MINISTERO DELLA DIFESA
ARMAEREO
ROMA

AER(EP).1F-EF2000(T)-1

FLIGHT MANUAL

EF2000 TWO SEATER SERIES AIRCRAFT

ALENIA
(A0019)

Commanders are responsible for bringing this publication to the attention of all personnel cleared for operation of subject aircraft.

01 DECEMBER 2002

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE

- The portion of the page affected by the change is indicated as described in the Introduction.

CAUTION

ENSURE THAT ANY PRECEDING CHANGES HAVE BEEN INCORPORATED BEFORE INSERTING LATEST CHANGE.

Dates of issue for original and changed pages are:

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Title Page	0	3-1 thru 3-64	0
A	0	4-1 thru 4-2	0
i thru viii	0	5-1	
1-1 thru 1-630	0	5-2 blank	0
2-1 thru 2-36	0	6-1 thru 6-6	0

WARNING

THIS PUBLICATION IS VALID ONLY WHEN COMPOSED OF THE ABOVE LISTED PAGES.

SCOPE

This manual contains necessary information for safe and efficient operation of the EUROFIGHTER two seater series aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal and emergency operating procedures. Your experience is recognized; therefore, basic flight principles are avoided. This manual provides the best possible operating instructions under most circumstances. However multiple emergencies, adverse weather, terrain etc. may require modification of the procedures.

PERMISSIBLE OPERATIONS

The flight manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Clearance must be obtained before any questionable operation, which is not specifically permitted in this manual, is attempted.

HOW TO BE ASSURED OF HAVING LATEST DATA

Check the flight manual title page, the title block and status page of the latest supplement.

ARRANGEMENT

This manual is divided into independent Sections and one Appendix to simplify reading it straight through or for using it as a reference manual. This Appendix, containing Performance Data, is issued as a separate volume AER(EP).1F-EF2000(T)-1-1.

SAFETY SUPPLEMENTS

Information involving safety will be promptly forwarded to you in a safety supplements. Urgent information is published in interim safety supplements. The supplements have to be inserted in the following order: Operational Supplements on top of the Flight Manual and Safety Supplements on the top of the Operational Supplements. The supplement title block and status page should be checked to determine the supplement's effect on the manual and other outstanding supplements.

OPERATIONAL SUPPLEMENTS

Information involving changes will be forwarded to you by operational supplements. The procedure for handling operational supplements is the same as for safety supplements.

CHECK LISTS

The flight manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplification. Primary line items in the flight manual and checklist are identical. If a formal safety or operational supplement affects your checklist, the affected checklist page will be replaced by an interim change.

WARNING

AT THE TIME OF PRINTING, THE CONTENTS OF THIS MANUAL ARE ALIGNED WITH THE FLIGHT CREW CHECKLIST. HOWEVER, LATER DEVELOPMENTS MAY CAUSE THE CHECKLIST TO BE FURTHER UPDATED. IN THE EVENT OF ANY CONTRAST WITH THE CHECKLIST, THE CHECKLIST TAKES PRECEDENCE. THIS MANUAL WILL SUBSEQUENTLY BE UPDATED AT THE EARLIEST OPPORTUNITY TO AGREE WITH THE CHECKLIST.

CHANGE SYMBOL

A black line in the outer margin of the paragraph, indicates text changes made to the current issue.

PUBLICATION DEFICIENCY REPORTING

Reporting of deficiencies such as errors or omissions in this manual shall be effected in accordance with AER.00-00-4.

WARNINGS, CAUTIONS AND NOTES

WARNING

OPERATING PROCEDURES, TECHNIQUES, ETC., WHICH COULD RESULT IN PERSONAL INJURY OR LOSS OF LIFE IF NOT CAREFULLY FOLLOWED.

CAUTION

OPERATING PROCEDURES, TECHNIQUES, ETC., WHICH COULD RESULT IN DAMAGE TO EQUIPMENT IF NOT CAREFULLY FOLLOWED.

NOTE

An operating procedure, technique, etc., which is considered essential to emphasize.

"SHALL", "WILL", "SHOULD" AND "MAY"

The words "shall" or "will" shall be used to express a mandatory requirement. The word "should" shall be used to express nonmandatory provisions. The word "may" shall be used to express permissiveness.

YOUR RESPONSIBILITY TO LET US KNOW

Every effort is made to keep the manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. We cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual are welcomed.

SOFTWARE CONFIGURATION

Information contained in this manual is applicable to EF2000 two seater series aircraft fitted with EJ200 MK 101engines.
The information contained in this manual reflects the following software configuration:
PSC 1.1

- APSP1 Avionic Software Package
- FPSP1a Flight Control System
- UPSP1b Utilities Control System

TABLE OF CONTENTS

SECTION 1 - DESCRIPTION 1-1

SECTION 2 - NORMAL PROCEDURES 2-1

SECTION 3 - EMERGENCY PROCEDURES 3-1

SECTION 4 - ADVERSE WEATHER 4-1

SECTION 5 - OPERATING LIMITATIONS 5-1

SECTION 6 - FLIGHT CHARACTERISTICS 6-1

LIST OF ABBREVIATIONS

SHORT TERM	DESCRIPTION
A & I	Attack and Identification
A/A	Air to Air
AB	Airbrake
AC	Alternate Current
AC	Attack Computer
ACFC	Air Cooled fuel Cooler
ACIS	Armament Carriage and Installation System
ACOC	Air Cooled Oil Cooler
ACS	Armament Control System
ADL	Automatic Data Link
ADT	Air Data Transducer
ADS	Air Data System
AFC	Automatic Frequency Control
AFCV	Air Flow Control Valve
AG	Attention Getter
AICS	Air Intake Control System
AIPT	Air Intake Pressure Transducer
AM	Amplitude Modulation
AMRAAM	Advanced Medium Range Air to Air Missile
AOA	Angle of Attack
APU	Auxiliary Power Unit
APUCU	APU Control Unit
ATC	Air Traffic Control
ATS/M	Air Turbine Starter Motor
AVS	Avionic System
AWFL	Aircraft Airworthiness Flight Limitations
AVSOV	Avionic Shut-Off Valve
BBS	Baseline Build Standard
BC	Bus Control
BIT	Built In Test

SHORT TERM	DESCRIPTION
BITE	Built In Test Equipment
CAMU	Communication and Audio Management Unit
CAS	Calibrated Airspeed
CAU	Cold Air Unit
CBIT	Continous BIT
C+D	Controls and Display Subsystem
CFG	Constant Frequency Generator
CG	Center of Gravity
CIU	Cockpit Interface Unit
COMMS	Communications
CPCV	Cabin Pressure Control Valve
CPU	Central Processing Unit
CSDB	Common Source Data Base
CSG	Computer Symbol Generator
CSMU	Crash Survivable Memory Unit
CSV	Cabin Safety Valve
CTCV	Cabin Temperature Control Valve
CTR	Center
DASS	Defensive Aids Subsystem
D+C	Display and Controls
DC	Direct Current
DECU	Digital Engine Control Unit
Deg/DEG	Degrees
DEK	Data Entry Keyboard
DIFU	DECU Interface Unit
DME-P	Distance Measuring Equipment - Precision
DRL	Data Requirement List
DTD	Document Type Definition

SHORT TERM	DESCRIPTION
DVI	Direct Voice Input
DWP	Dedicated Warning Panel
EBSOV	Engine Bleed Shut-Off Valve
ECCM	Electronic Counter Counter Measures
ECR	Electronic Counter Reconaissance
ECS	Environmental Control System
ECU	Electronic Control Unit
EF2000	European Fighter 2000 Aircraft
EGT	Exhaust Gas Temperature
EMS	Engine Monitoring System
EPS	Emergency Power System
EPU	Emergency Power Unit
ERA	Emergency Ram Air
ERU	Ejection Release Unit
FCC	Flight Control Computer
FCOC	Fuel Cooled Oil Cooler
FCS	Flight Control System
FLIR	Forward Looking Infra Red
FRP	Flight Refueling Probe
FRS	Flight Resident Software
FT/ft	Feet
FTI	Flight Test Instrumentation
FWD	Forward
GB	Gearbox
GCU	Generator Control Unit
GLU	Ground Loading Unit
GPC	Ground Power Connector
GPS	Global Positioning System
GPU	Ground Power Unit
GTE	Ground Test Equipment
GUH	Get-U-Home
GU	Guard UHF
GV	Guard VHF
HDD	Head Down Display
HDG	Heading
HF	High Frequency
HOTAS	Hands On Throttle and Stick
HP	High Pressure
HUD	Head Up Display
HYD	Hydraulic
IAS	Indicated Airspeed
IBIT	Initiated BIT
ICU	Interface Control Unit
IFF	Identification Friend or Foe
IFR	In-Flight Refueling
IMRS	Integrated Monitoring and Recording Subsystem
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IPU	Interface Processor Unit
ISA	International Standard Atmosphere
KCAS	Knots Calibrated Airspeed/Knots Corrected Airspeed
KDAS	Knots Displayed Airspeed
KEAS	Knots Equivalent Airspeed
kg	Kilogramme(s)
KN	Kilonewton(s)
KPa	Kilopascal(s)
kT/kt	Knots
KW	Kilowatt(s)
LDERU	Light Duty ERU
LES	Leading Edge System
LG	Landing Gear

SHORT TERM	DESCRIPTION
LGC	Landing Gear Computer
LHGS	L/H Glareshield
LINS	Laser Inertial Navigator
LP	Low Pressure
LRI	Line Replaceable Item
LTR/ltr	Liter
M	Mach
MASS	Master Arm Safety Switch
MDE	Manual Data Entry
MDLR	Mission Data Loader and Recorder
MDP	Manual Data Panel
MDR	Manual Data Recorder
MEL	Medium Range Air to Air Eject Launcher
MHDD	Multi Function Head Down Display
MIDS	Multi-Functional Information Distribution System
MK	Mark
MLG	Main Landing Gear
MLS	Microwave Landing System
MRAAM	Medium Range Air to Air Missile
MSL	Mean Sea Level
MSOC	Molecular Sieve Oxygen Concentrator
MSOG	Molecular Sieve Oxygen Generation
N/A	Not Applicable
NBC	Nuclear, Biological and Chemical
NC	Navigation Computer
NLG	Nose Landing Gear
NM	Nautical Miles
NRV	Non Return Valve
NSCAC	Non Safety Critical Armament Controller
NWS	Nose Wheel Steering
ODM	Operational Data Manuals
OTF	On Top Fixing
PBIT	Power-Up BIT
PDC	Portable Data Carrier
PDU	Pylon Decoder Unit/Pilot's Display Unit
PIO	Pilot Induced Oscillation
PP	Present Position
PRSOV	Pressure Regulating and Shut-Off Valve
PRV	Pressure Reducing Valve
PSP	Personal Survival Pack
PTO	Power Take Off
PTT	Push to Talk
QA	Quality Assurance
QAWP	Quality Assurance and Airworthiness Panel
QTY	Quantity
RAD ALT	Radar Altimeter
RF	Radio Frequency/Rear Fuselage
RFA	Request For Alteration
RH	Right Hand
RMS	Root Mean Square
RNG	Range
ROL	Readout Lines
RPM	Revolution Per Minute
R/T	Radio Transmission
RT	Remote Terminal
RTB	Return to Base
RTO	Rejected Takeoff
RX	Receiver
SCA	Sub Contract Annex/ Software Change Amendment
SCAC	Safety Critical Armament Controller

SHORT TERM	DESCRIPTION
SDR	System Design Responsibility
Sec	Seconds
SK	Softkey
SL	Sea Level
SOV	Shut-Off Valve
SPS	Secondary Power System
SPSCU	Secondary Power System Control Unit
SRD	Software Requirement Document
STOL	Short Takeoff/Landing
STTE	Special To Type Test Equipment
S/W	Software
SWP1-5	Software Package (1-5)
TACAN	Tactical Air Navigation
TBA	To Be Advised
TBD	To Be Decided
TBT	Turbine Blade Temperature
TCV	Temperature Control Valve
TMC	Twin Missile Carrier
TO	Takeoff
T/R	Transmitter/Receiver
TRU	Transformer Rectifier
TSC	Twin Store Carrier
TSU	Tip Station Unit
TTU	Triplex Transducer Unit
TX	Transmitter
UCS	Utilities Control System
UHF	Ultra High Frequency
V	Volt
V/UHF	Very/Ultra High Frequency
VHF	Very High Frequency
VPROSV	Variable Pressure Regulating and Shut-Off Valve
VVR	Video Voice Recorder
VWS	Voice Warning System

LIST OF INCORPORATED SUPPLEMENTS

This list shows all “Safety Supplements” (SS) and “Operational Supplements” (OS) incorporated either in this issue or in previous issues of this manual.

SUPPLEMENTS	DATE	TITLE	INCORPORATED IN (ISSUE/CHANGES)		
			ISSUE DATE	CHANGE NO.	CHANGE DATE
NONE					

LIST OF INCORPORATED PTA

This list contains only modifications affecting the contents of this manual. Following embodiment of a modification in all affected aircraft, the corresponding number will not be deleted from this list, but the information regarding the pre-modification configuration will be deleted from the manual.

COMPANY DOCUMENT			MINISTRY OF DEFENCE DOCUMENT		TITLE
MODIFICATION			PRESCRIZIONE TECNICA APPLICATIVA		
No.	Date	Class	No.	Date	
NONE					

SECTION 1 - DESCRIPTION

TABLE OF CONTENTS

Title ..... Page
THE AIRCRAFT 1-3
The Aircraft 1-3
Aircraft Dimensions 1-3
Three Quarter View of Aircraft 1-3
Aircraft General Arrangement 1-5
Aircraft Gross Mass 1-7
COCKPIT DISPLAYS AND CONTROLS 1-7
Cockpit Layout 1-7
Cockpit Layout 1-10
General Electronic Displays 1-31
Head up Display 1-34
Head up Display 1-57
Multifunction Head down Display 1-60
Multifunction Head down Display 1-88
Manual Data Entry 1-92
Miscellaneous MDE 1-98
Hands on Throttle and Stick 1-107
Get-U-Home Instruments 1-113
Computer Symbol Generator 1-117
Ground Proximity Warning System 1-117
UTILITIES CONTROL SYSTEM 1-125
Utilities Control System 1-125
UCS Computers 1-125
UCS Data Bus and Interfaces 1-131
Maintenance Data Panel 1-133
ENGINES 1-136
Engines 1-136
Engine Air System 1-139
Engine Oil System 1-139
Engine Fuel Control System 1-140
Digital Engine Control Unit 1-140
Engine Monitoring System 1-141
Engine Starting System 1-141
Engine Airflow Control System 1-141
Engine Reheat System 1-144
Air Intake Cowls 1-144
Engine Operation 1-146
Engine Handling in Flight 1-148
Throttles 1-148
Engine Controls and Indicators 1-151
SECONDARY POWER SYSTEM 1-153
Secondary Power System 1-153
Auxiliary Power Unit 1-161
APU Operation 1-161
SPS 1-163
ENGINE/APU FIRE PROTECTION SYSTEM 1-168
Engine/APU Fire Protection System 1-168
FUEL SUPPLY SYSTEM 1-171
Fuel System 1-171
Fuel Tanks 1-171
Fuel Transfer System 1-173
Fuel Pressurization and Vent System 1-179
Fuel/Oil Cooling System 1-181
Engine and APU Fuel Supply System 1-183
Ground Refueling and Defueling 1-185
Air to Air Refueling 1-188
Fuel Masses 1-188
Fuel System 1-189
ELECTRICAL POWER SUPPLY SYSTEM 1-197
Electrical Power System 1-197
AC Power Supply and Distribution 1-200
DC Power Supply and Distribution 1-203
Electrical Power System 1-210
HIDRAULIC POWER SUPPLY SYSTEM 1-214
Hydraulic Power Supply System 1-214
Hydraulic System - Main Components 1-216
Hydraulic System 1-217
LANDING GEAR SYSTEM 1-221
Landing Gear System 1-221
Main/Nose Gear 1-222
Landing Gear Emergency System 1-222
Wheel Brake System 1-223
Anti Skid System 1-224
Landing Gear System 1-224
ARRESTER HOOK SYSTEM 1-226
Arrester Hook System 1-226
BRAKE CHUTE SYSTEM 1-227
Brake Chute System 1-227
FLIGHT CONTROL SYSTEM 1-230
Flight Control System 1-230
Flight Control System (Twin Seat) 1-237
Foreplane 1-247
Flaperons 1-248
Rudder 1-248
Leading Edge System 1-248
Nosewheel Steering 1-249
Airbrake 1-251
Trim System 1-253
Flight Control System Computer Functions 1-254
Flight Control System Built In Test 1-255
Flight Control System (TWS) 1-256
AUTOPILOT AND AUTOTHROTTLE SYSTEM 1-260
Autothrottle (AT) at FPSP1a 1-260
AIR DATA SYSTEM 1-267
Air Data System 1-267
Air Data System 1-271
CANOPY 1-271
Canopy and Windscreen 1-271
Canopy Raising and Lowering 1-272
Canopy and Windscreen 1-272
ESCAPE SYSTEM 1-278
Escape System 1-278

Ejection Seat 1-278
Ejection Seat 1-283
Ejection Sequence 1-286
Minimum Ejection Heights..... 1-292
Aircrew Equipment Assembly 1-294
Canopy Jettison System 1-297
Canopy Jettison System 1-300
ENVIROMENTAL CONTROL STSTEM..... 1-302
Environmental Control System..... 1-302
Environmental Control System..... 1-304
Canopy and Windscreen Sealing..... 1-304
Cabin Air Suppy System 1-305
Pressurization System 1-305
Avionic Air Supply System 1-307
Avionic Liquid Cooling System..... 1-307
Antimist/Demist System 1-309
Emergency Ram Air 1-309
Ice Detection 1-309
Environmental Control System..... 1-309
OXIGEN SYSTEM..... 1-313
Oxygen System..... 1-313
Molecular Sieve Oxygen Generation 1-316
Auxiliary Oxygen System 1-318
Anti-G System 1-320
LIGHTING SYSTEM..... 1-322
Lighting System..... 1-322
AVIONIC SYSTEM INTEGRATION 1-328
Avionics System Integration..... 1-328
System Software 1-340
NAVIGATION SYSTEM 1-340
Navigation System 1-340
Navigation Fixing..... 1-343
Navigation Steering..... 1-346
Navigation Modes 1-362
Laser Inertial Navigator System (LINS).. 1-364
Navigation Computer 1-366
Global Positioning System Upgradeable 1-367
Radar Altimeter 1-369
TACAN..... 1-373
Navigation System 1-380
COMMUNICATION SYSTEM 1-397
Communication Equipment 1-397
V/UHF Radio 1-397
Communications and Audio Management Unit..... 1-397
Communication 1-398
Communication Equipment 1-400
WARNING EQUIPMENT..... 1-426
Audio Warning Equipment 1-426
Warnings Management and Failure Analysis..... 1-428
Dedicated Warning Panel 1-433
Audio/Visual Warnings..... 1-435
Fire Warning System..... 1-444
Get-U-Home Warnings..... 1-447
RECORDERS 1-449
Integrated Monitoring and Recording System..... 1-449
Mission Data Loader/Recorder..... 1-450
Video/Voice Recorder 1-452
Crash Survivable Memory Unit..... 1-454
Cryptovariable Management System 1-454
SUIRVELLANCE/ATTACK AND IDENTIFICATION 1-458
Surveillance/Attack and Identification Subsystem 1-458
Surveillance/Attack and Identification..... 1-472
Radar..... 1-483
Radar..... 1-484
Radar..... 1-501
Radar..... 1-524
Identification System 1-540
Identification System 1-540
Identification System 1-544
Identification System (IFF) 1-547
DEFENSIVE AIDS SUBSYSTEM..... 1-580
Defensive Aids Subsystem..... 1-580
Defensive Aids Computer..... 1-585
Defensive Aids Subsystem..... 1-586
Defensive Aids Subsystem..... 1-589
Data Loading/Erasing..... 1-593
Transmitter Management 1-593
WEAPON SYSTEM..... 1-600
Weapon Aiming/Release System..... 1-600
Armament Control Subsystem 1-601
Armament Safety System..... 1-608
Stores 1-616
Armament Carriage and Installation System (ACIS) 1-619
MISCELLANEOUS..... 1-622
Cockpit Access Ladder..... 1-622
Servicing Diagram 1-629

THE AIRCRAFT

The Aircraft

(1B-B-00-00-10-00A-043A-A Issue 004)

The EF-2000 is a high performance, supersonic, all-weather air-superiority fighter built by EuroFighter Company. Its primary mission is aerial combat, but it can also perform ground attack missions. The ECR 90 radar and the SRAAM and MRAAM missiles are the primary armament.

External stores can be carried on thirteen hardpoints, three of which can be used for external fuel tanks. Up to ten air-to-air missiles can be carried. Air-to-surface munitions can be fitted to seven of the hardpoints, while still retaining six air-to-air missiles. The aircraft has a single internally mounted 27 mm Mauser gun.

The aircraft is powered by two Eurojet EJ200 MK 101 two-spool axial flow turbofan engines, with afterburner.

The aircraft features a variable camber delta wing. Automatic slats on the wing leading edges and full span inboard and outboard flaperons on the wing trailing edges provide optimum wing camber at all angles of attack. Symmetrical foreplanes provide control and additional lift. The aircraft also has a conventional rudder. The airbrake is mounted on the top side of the central fuselage. The aircraft is aerodynamically unstable. Artificial stability is provided by a full authority quadruple "fly-by-wire" flight control system. Pitch control is by means of the foreplanes and the flaperons. Roll and yaw controls is by means of the flaperons and the rudder.

The pressurized cabin is enclosed by an electrically operated clamshell canopy. The ejection seat provides safe escape from zero airspeed, zero height conditions.

An aircraft mounted auxiliary power unit (APU) provides compressed air to the air turbine starter motors (ATSM) for gearbox/system checking or engine starting and the environmental control system (ECS) for cockpit conditioning. Limited electrical power is provided to the aircraft systems from the APU generator. The APU can only be operated on the ground and allows the aircraft to operate independently of ground facilities.

The two seat aircraft is a tandem configured aircraft which performs the secondary role of a trainer without compromising its primary role. Using the front cockpit controls the two seat aircraft provides equivalent navigation and weapon system capabilities as those available in the single seat aircraft. The rear cockpit controls duplicate most front cockpit controls for navigation and weapon system control.

Aircraft Dimensions

(1B-B-06-10-00-00A-043A-A Issue 003)

The overall dimensions of the aircraft are as follows:

Span	10.95 meters
Length	15.97 meters
Height	5.29 meters
Wheel track	4.04 meters
Wheel base	4.22 meters

Three Quarter View of Aircraft

(1B-B-06-12-00-00A-043A-A Issue 003)

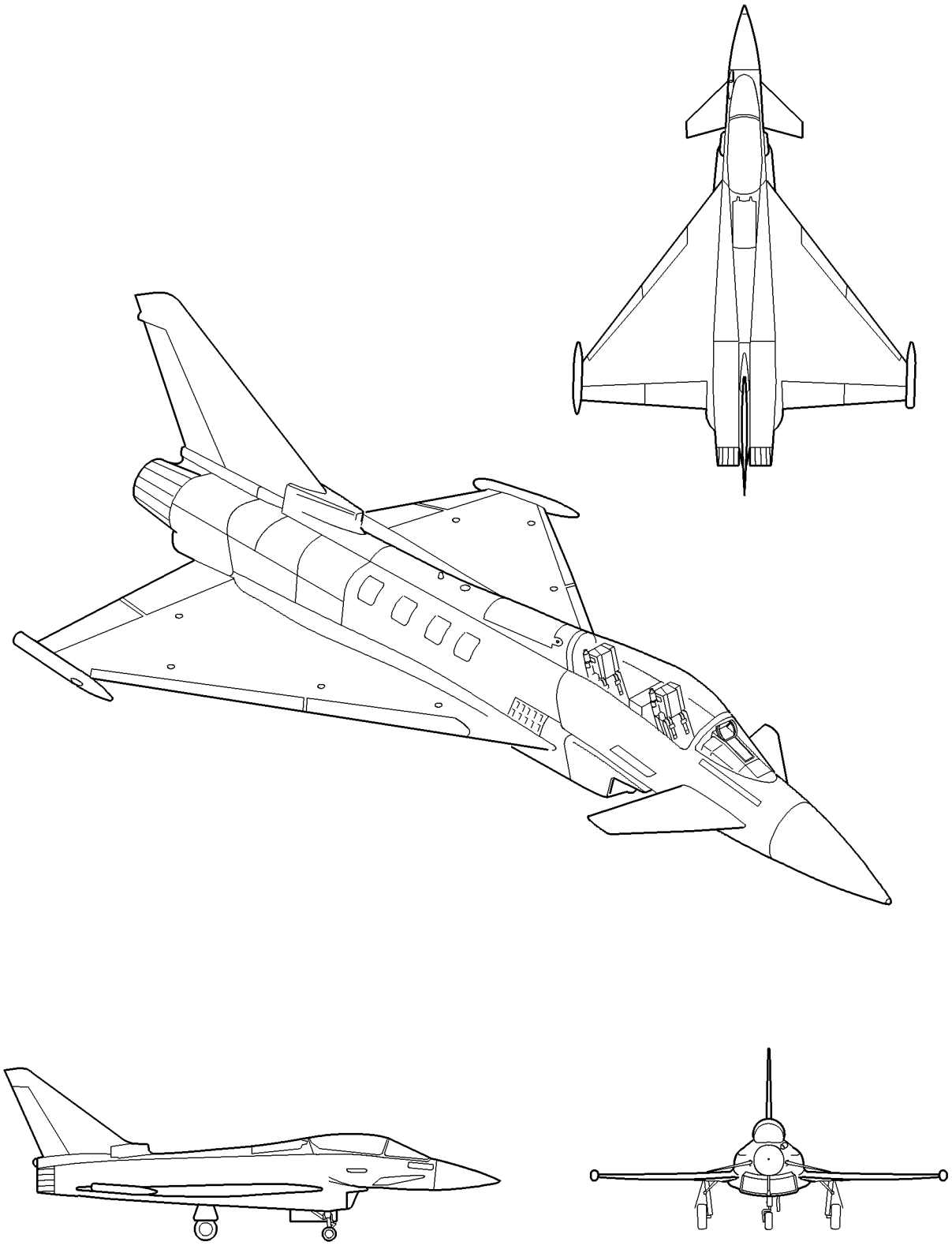


Figure 1.1 - Three Quarter View - Twin Seat

Aircraft General Arrangement

(1B-B-06-14-00-00A-043A-A Issue 003)

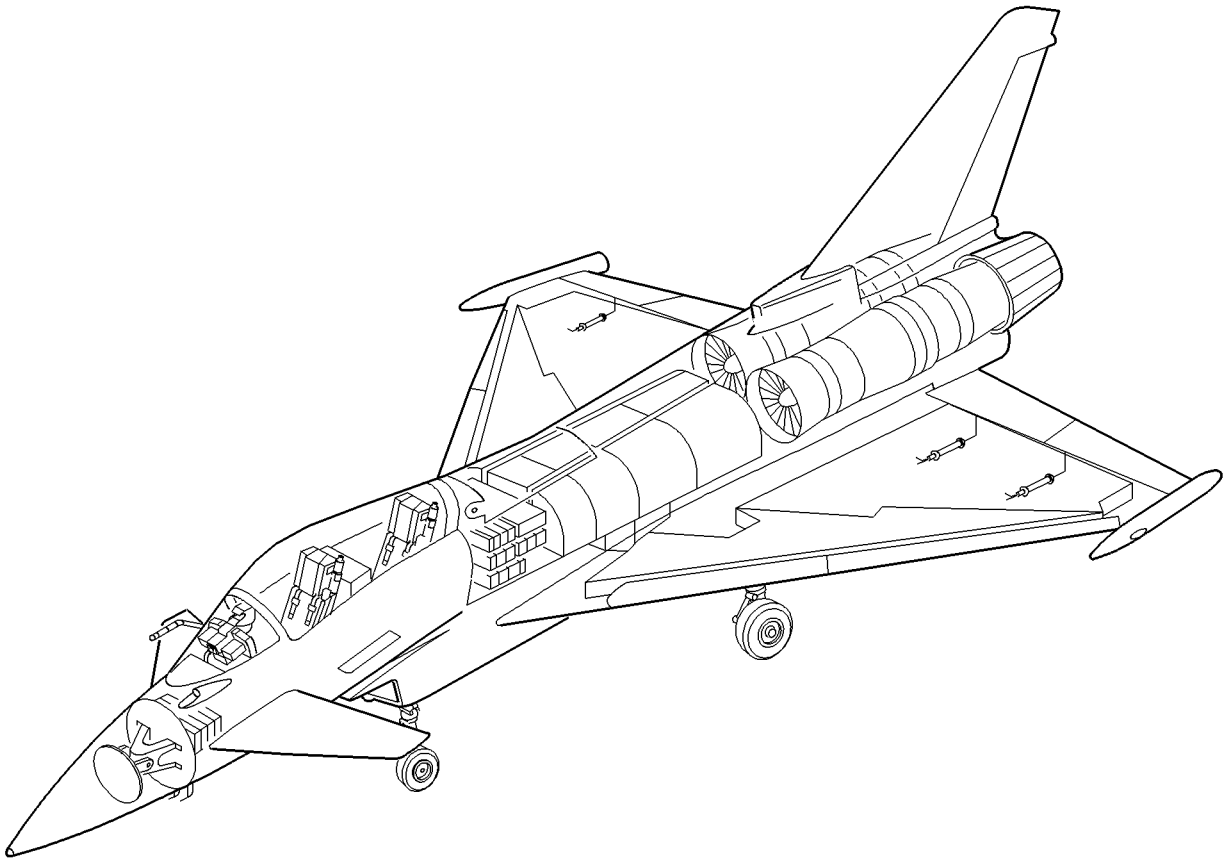


Figure 1.2 - Aircraft General Arrangement - Twin Seat

Aircraft Gross Mass

(1B-B-08-40-00-00A-043A-A Issue 004)

The following gross masses are approximate and shall not be used for computing aircraft performance or for any type of operation.

Gross Masses

CONFIGURATION	MASS (KG)
OPERATIVE GROSS MASS EMPTY (BASIC GROSS MASS EMPTY PLUS AIRCREW PLUS OIL PLUS 4 MEDIUM RANGE AIR-TO-AIR EJECT LAUNCHERS PLUS 2 INTEGRATED TIP STUB PYLON/LAUNCHERS)	12 300
Takeoff gross mass (operative gross mass empty plus full internal fuel plus 4 advance medium range air-to-air missiles (AMRAAM) plus 2 side winders AIM-9L)	17 300
Takeoff gross mass as above plus 3 full 1000 liter supersonic external fuel tanks (SFT)	20 200
Takeoff gross mass (operative gross mass empty plus full internal fuel plus 2 outboard wing pylons plus 4 AMRAAMs plus 6 side winders AIM-9L)	18 100
Takeoff gross mass as above plus 3 full SFTs	21 000

COCKPIT DISPLAYS AND CONTROLS

Cockpit Layout

(1B-B-31-00-00-00A-043A-A Issue 005)

Introduction

The aircrew face a display suite comprising a wide angle Head Up Display (HUD) and three full color, raster/cursive Multifunction Head Down Display (MHDD).

Under normal circumstances, the MHDD and HUD present all the information required by the aircrew to manage and operate the aircraft. A number of reversionary and Get-You-Home (GUH) instruments, located predominantly on the right glareshield, provide the aircrew with basic flight data in the event of main display failures. During normal operation the GUH instruments (speed, Mach, altitude and vertical speed displays), on the right glareshield, are covered by a Dedicated Readout Panel (DRP). In general, the controls and displays interface with their respective systems via the cockpit bus, and other data busses, but for integrity reasons a number of controls are hardwired.

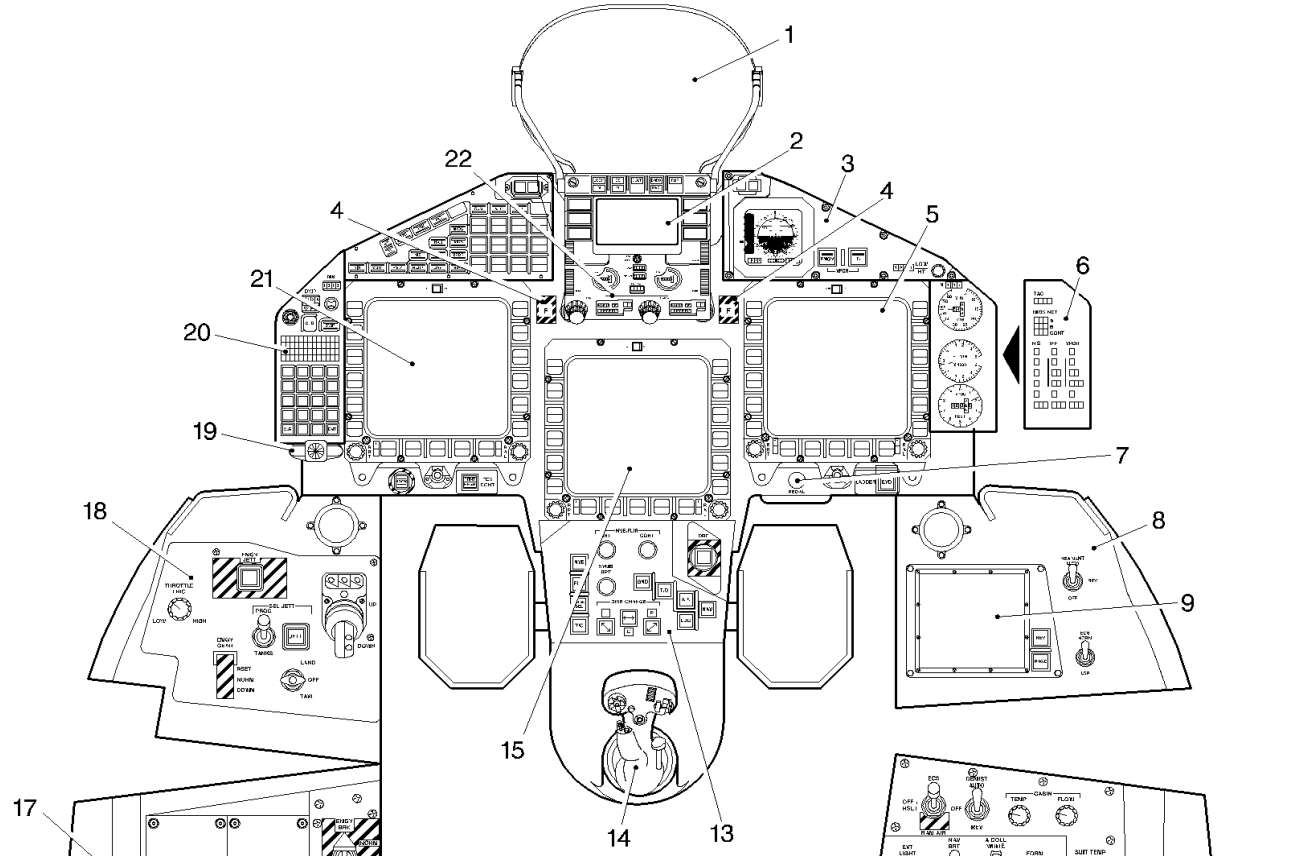
The Manual Data Entry (MDE) facility, located on the left glareshield, enables the aircrew to alter previously entered data or insert new information. The left and right throttle arrangements, located on the left console, occupy the majority of the forward outboard area. The remaining area of the left console provide locations for various systems, controls and indicators, including flight control and communications systems. Similarly, controls and indicators for miscellaneous systems, including hydraulic, engine starting, lighting and environmental control, are arranged on the right console.

Each quarter panel incorporates an Environment Control System (ECS) vent. The left quarter panel also contains various quick-reaction and emergency controls and indicators associated with landing, takeoff and emergency functions. A Dedicated Warning Panel (DWP) and it's associated controls are located on the right quarter panel.

A handle, located below the right MHDD, allows the aircrew to adjust the rudder pedals.

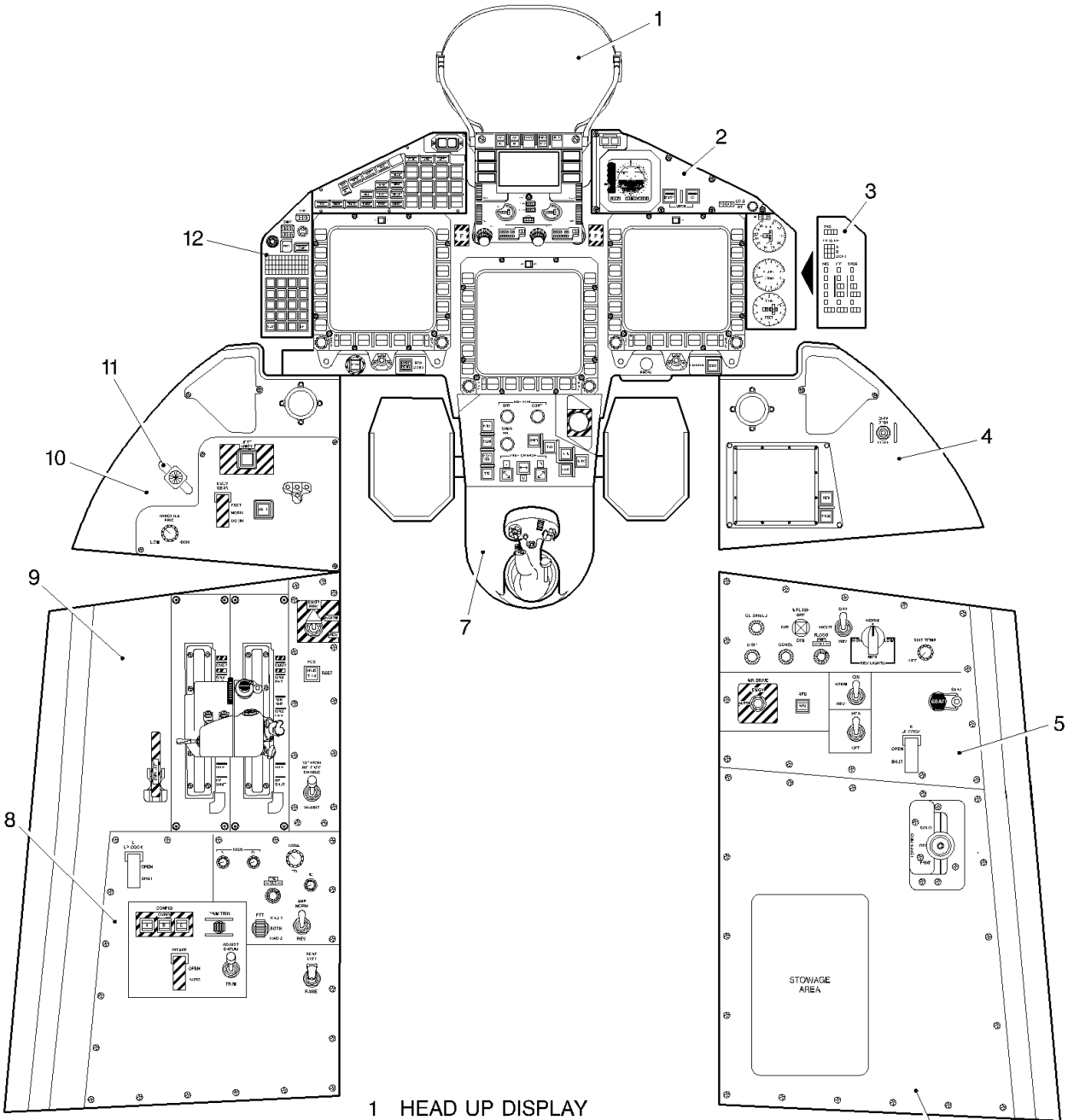
A fire indicator/extinguisher button is located on each side of the HUDCP.

The front cockpit seat and canopy safety pins are stowed on the outboard side of the right rear console. The rear cockpit seat safety pin is stowed on the outboard side of the right forward console.



1 HEAD UP DISPLAY
2 HUD CONTROL PANEL
3 RIGHT GLARESHIELD
4 FIRE INDICATOR/EXTINGUISHER BUTTON
5 RIGHT MHDD
6 DEDICATED READ OUT PANEL
7 RUDDER PEDAL ADJUSTMENT HANDLE
8 RIGHT QUARTER PANEL
9 DEDICATED WARNING PANEL
10 RIGHT CONSOLE
11 BATTERY GANGBAR
12 SYSTEMS GANGBAR
13 PEDESTAL PANEL
14 CONTROL STICK
15 CENTER MHDD
16 LEFT CONSOLE
17 THROTTLES
18 LEFT QUARTER PANEL
19 BRAKE PARACHUTE HANDLE
20 LEFT GLARESHIELD
21 LEFT MHDD
22 FUEL AND ENGINE INDICATORS

Figure 1.3 - Front Cockpit Layout



1 HEAD UP DISPLAY
2 RIGHT GLARESHIELD
3 DEDICATED PANEL READ-OUT
4 RIGHT QUARTER PANEL
5 FORWARD RIGHT CONSOLE
6 AFT RIGHT CONSOLE
7 PEDESTAL PANEL
8 AFT LEFT CONSOLE
9 FORWARD LEFT CONSOLE
10 LEFT QUARTER PANEL
11 BRAKE PARACHUTE HANDLE
12 LEFT GLARESHIELD

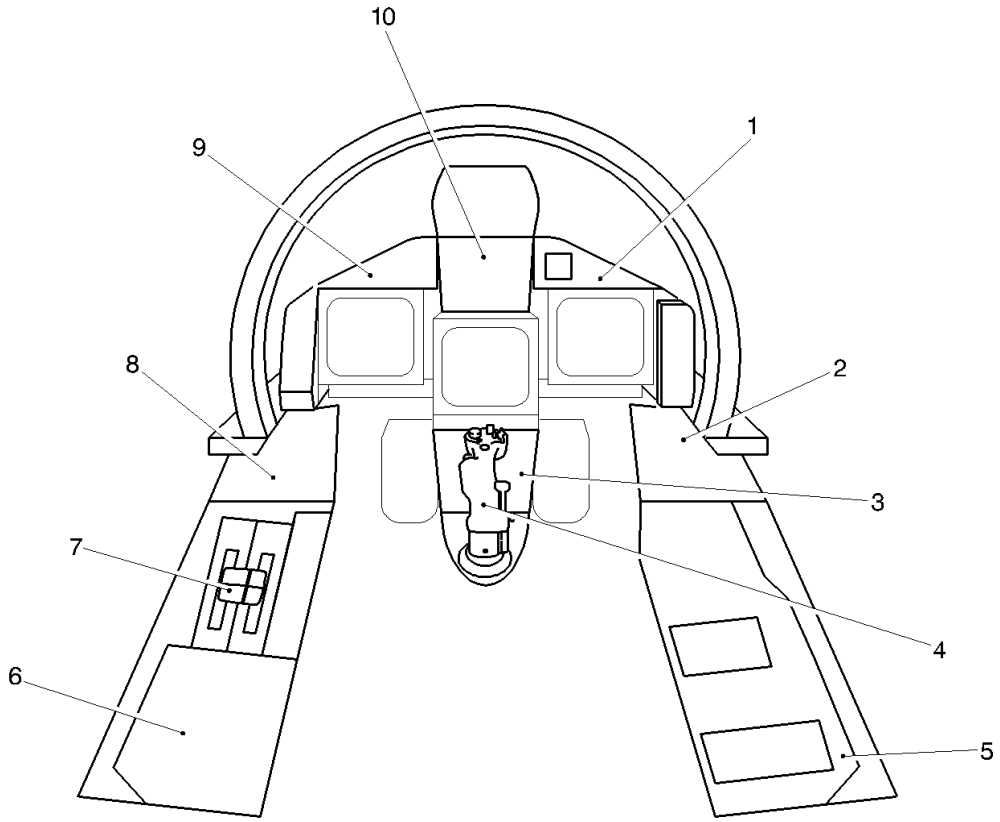
Figure 1.4 - Rear Cockpit Layout

Cockpit Layout

(1B-B-31-00-00-00A-111A-A Issue 004)

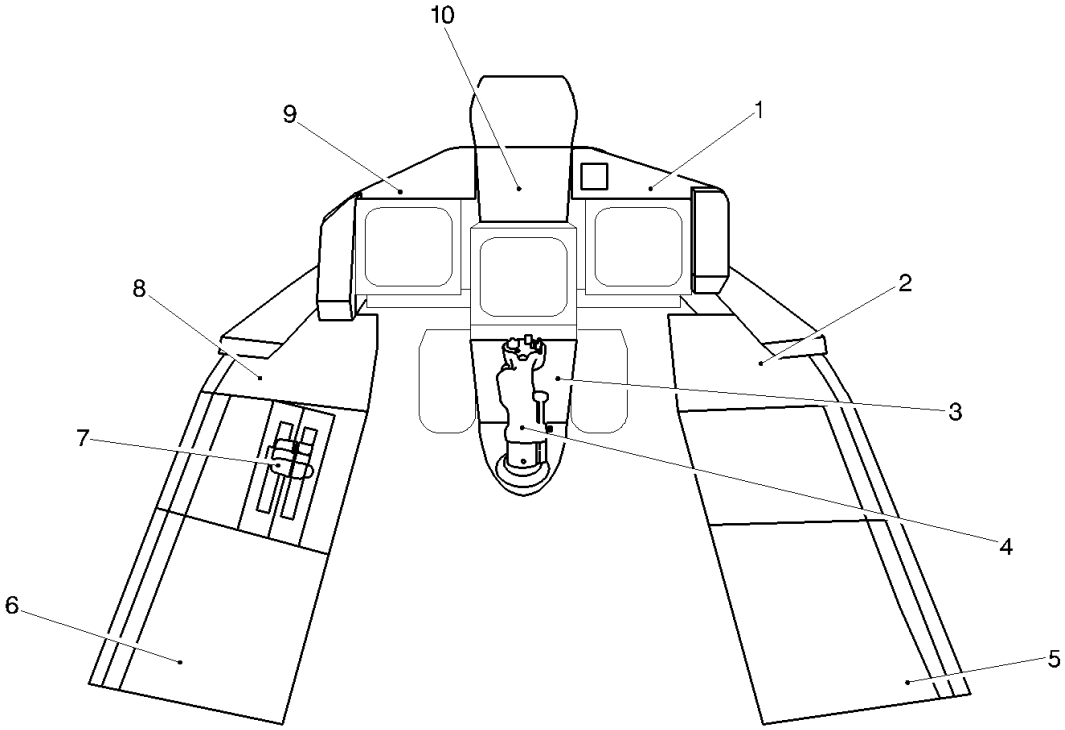
Introduction

The cockpit controls and indicators are located on consoles and panels. The layout of these consoles and panels within the front cockpit are shown in Figure 1.5. The position of each control and indicator is shown in Figure 1.7 thru Figure 1.17 .
Stick top and throttle controls and switches are described in Hands on Throttle and Stick pag. 1-107.
The layout of consoles and panels in the rear cockpit is shown in Figure 1.6 . The rear cockpit layout differences are shown in Figure 1.18 thru Figure 1.24 .



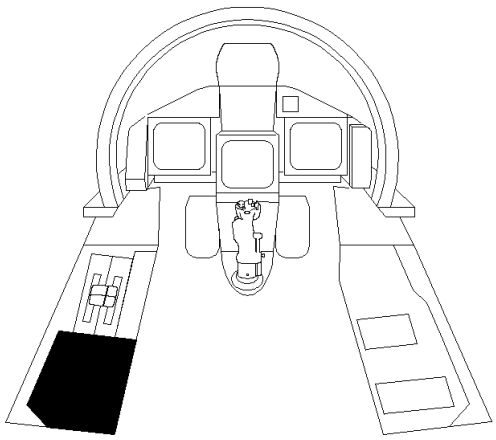
1 RIGHT GLARESHIELD
2 RIGHT QUARTER PANEL
3 PEDESTAL PANEL
4 CONTROL STICK
5 RIGHT CONSOLE
6 LEFT CONSOLE
7 THROTTLES
8 LEFT QUARTER PANEL
9 LEFT GLARESHIELD
10 HEAD-UP PANEL

Figure 1.5 - Cockpit Controls and Panels



1 RIGHT GLARESHIELD
2 RIGHT QUARTER PANEL
3 PEDESTAL PANEL
4 CONTROL STICK
5 RIGHT CONSOLE
6 LEFT CONSOLE
7 THROTTLES
8 LEFT QUARTER PANEL
9 LEFT GLARESHIELD
10 HEAD-UP PANEL

Figure 1.6 - Rear Cockpit Controls and Panels



1 LEFT HAND LOW PRESSURE COCK CONTROL
2 YAW TRIM CONTROL
3 TOWED DECOY DEPLOYMENT CONTROL
4 PROGRAMMED EXPENDABLES MANUAL RELEASE CONTROL
5 TACAN/MLS AUDIO TONE VOLUME CONTROL
6 MIDS VOICE CHANNEL A VOLUME/TRANSMISSION CONTROL
7 MIDS VOICE CHANNEL B VOLUME/TRANSMISSION CONTROL
8 MISSILE AUDIO/TELEBRIEF VOLUME/TRANSMISSION CONTROL
9 GENERAL INTERCOMMUNICATION AUDIO VOLUME/ TRANSMISSION CONTROL
10 DEFAULT AUDIO MODULE VOLUME SELECTION CONTROL
11 RADIO AMPLIFICATION MEDIUM CONTROL
12 DUPLICATE PRESS TO TRANSMIT CONTROL
13 SEAT LOWER/RAISE CONTROL
14 CRYPTOGRAPHIC VARIABLE ERASURE CONTROL
15 PARKING BRAKE CONTROL
16 RIGHT HAND GEARBOX PNEUMATIC DRIVE CONTROL
17 LEFT HAND GEARBOX PNEUMATIC DRIVE CONTROL
18 RADAR PROTECTIVE INTERLOCK OVERRIDE CONTROL
19 TRIM/AUTOPILOT DATUM ADJUST SELECT SWITCH
20 PRIORITY COCKPIT SELECTOR
21 ENGINE INTAKE COWL CONTROL
22 FCS TEST CONTROL
23 CONFIGURATION CONTROL OVERRIDE SELECTION

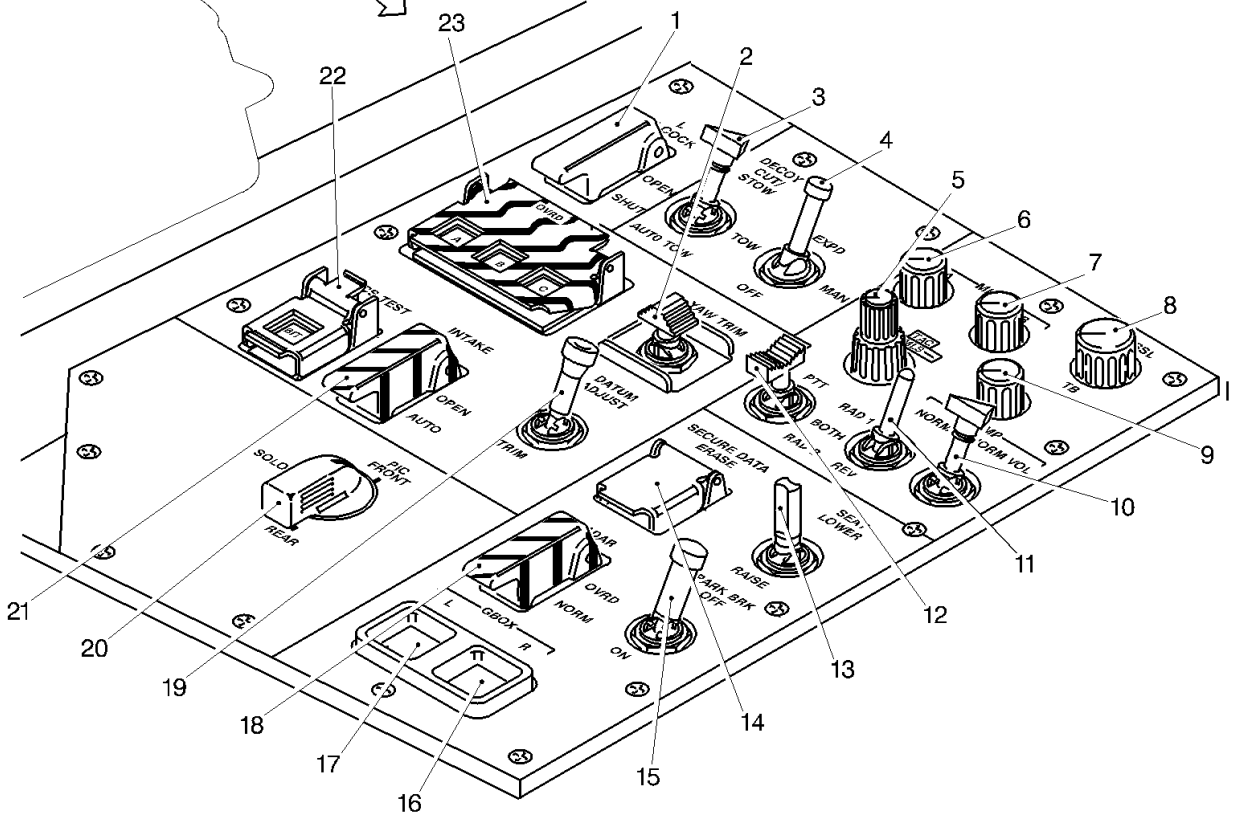


Figure 1.7 - Left Rear Console

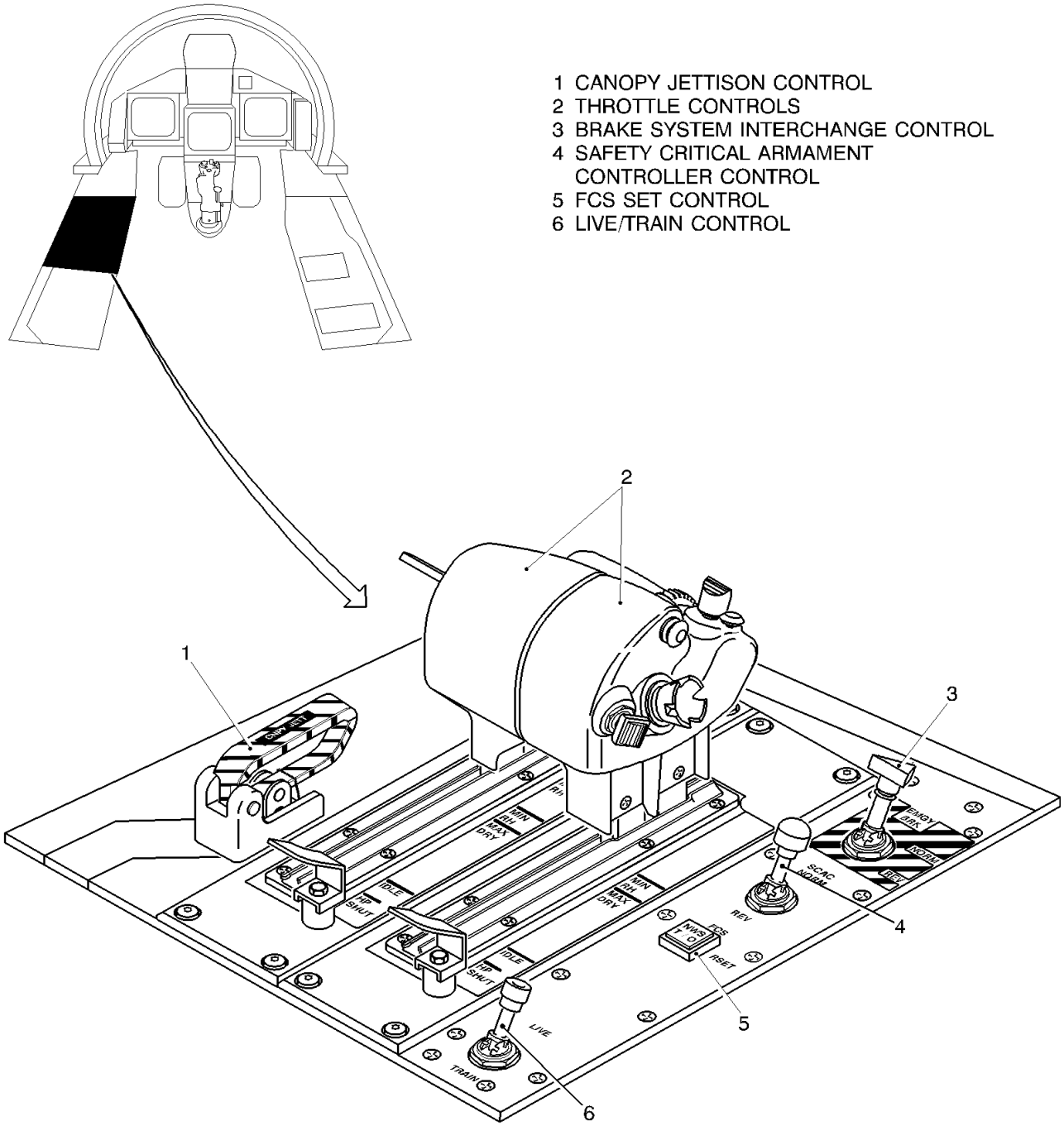
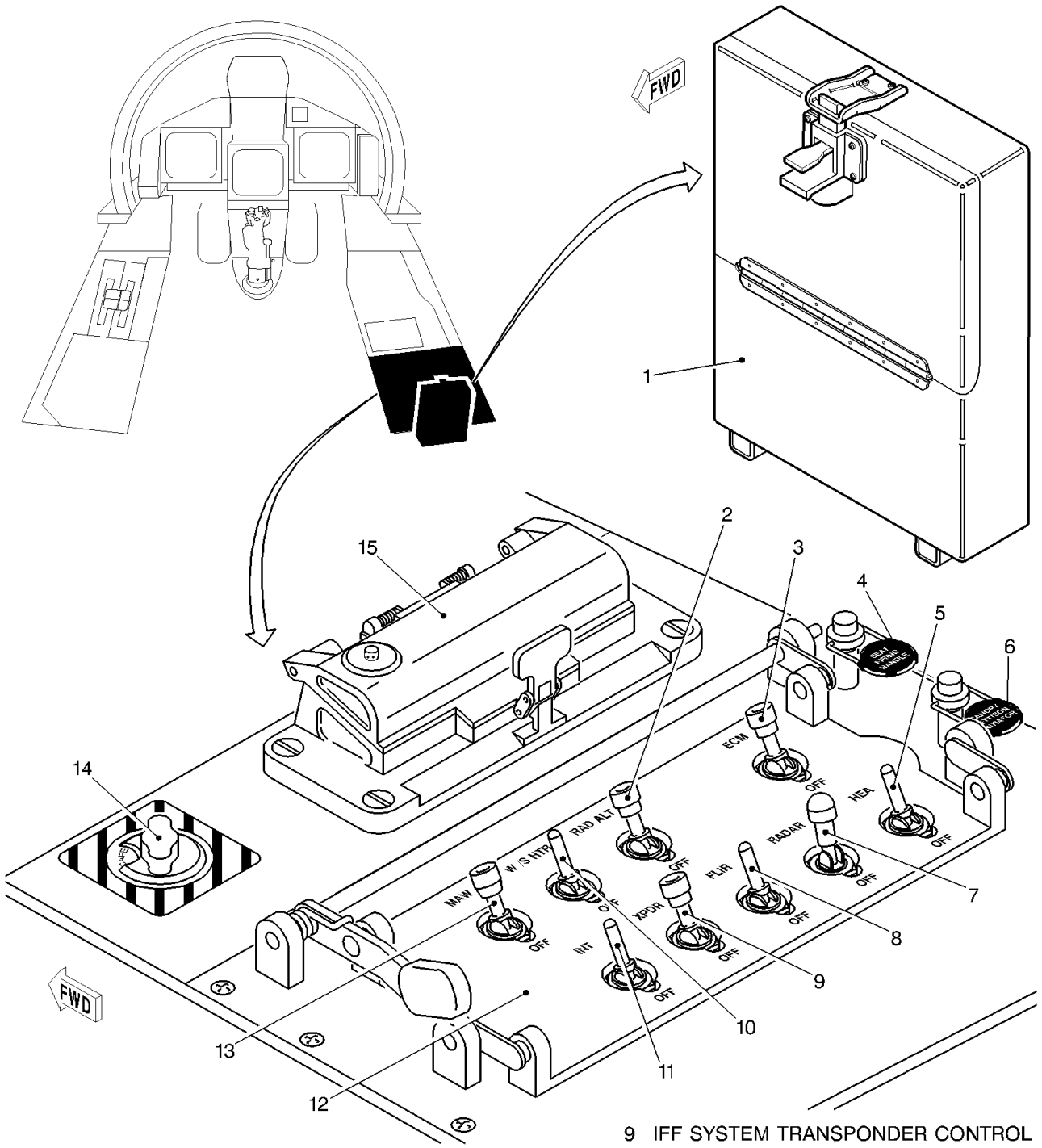


Figure 1.8 - Left Forward Console



1 BULKHEAD STOWAGE BOX
2 RADAR ALTIMETER TRANSMISSION CONTROL
3 ECM ENABLE CONTROL
4 EJECTION SEAT SAFETY PIN STOWAGE
5 HELMET EQUIPMENT ASSEMBLY CONTROL
6 CANOPY JETTISON HANDLE SAFETY PIN STOWAGE
7 RADAR TRANSMISSION CONTROL
8 FLIR SEEKER HEAD COOLING CONTROL
9 IFF SYSTEM TRANSPONDER CONTROL
10 WINDSCREEN HEATING ELEMENT ENERGIZING CONTROL
11 IFF SYSTEM INTERROGATOR CONTROL
12 SYSTEMS GANGBAR
13 MAW ENABLE CONTROL
14 MASS
15 MISSION DATA LOADER/RECORDER

Figure 1.9 - Right Rear Console

1 AIRSYSTEM MASTER CONTROL
2 ANTIMIST/DEMIST CONTROL
3 CABIN TEMPERATURE CONTROL
4 ANTICOLLISION LIGHTS CONTROL
5 CABIN AIRFLOW CONTROL
6 FORMATION LIGHTS CONTROL
7 LIGHTING SYSTEM MODE CONTROL
8 SUIT TEMPERATURE CONTROL
9 REVERSIONARY LIGHTING SELECTOR
10 CANOPY CONTROL
11 VENT CONTROL
12 COMPUTER SYMBOL GENERATOR CHANGE OVER CONTROL
13 VIDEO VOICE RECORDER CONTROL
14 RIGHT HAND LP COCK CONTROL
15 STOWAGE BOX
16 APU CONTROL
17 APU STATUS INDICATOR
18 COCKPIT INTERFACE UNIT CHANGE OVER CONTROL
19 MIDS TRANSMITTER CONTROL
20 RADIO 2 TRANSMITTER CONTROL
21 RIGHT HAND FUEL BOOST PUMP CONTROL
22 RADIO 1 TRANSMITTER CONTROL
23 BATTERY MASTER CONTROL
24 VOICE WARNING AUDIO CONTROL
25 BATTERY GANGBAR
26 LEFT HAND FUEL BOOST PUMP CONTROL
27 FUEL CROSSFEED CONTROL
28 FLIGHT REFUELLING PROBE CONTROL
29 FWD/AFT FLOODLIGHT LUMINANCE CONTROL
30 PNEUMATIC DRIVE MASTER CONTROL
31 CONSOLE LUMINANCE CONTROL
32 MAIN DISPLAY LUMINANCE CONTROL
33 ANTI FLASH CONTROL
34 GLARESHIELD LUMINANCE CONTROL
35 EXTERNAL LIGHTS CONTROL
36 NAVIGATION LIGHTS CONTROL

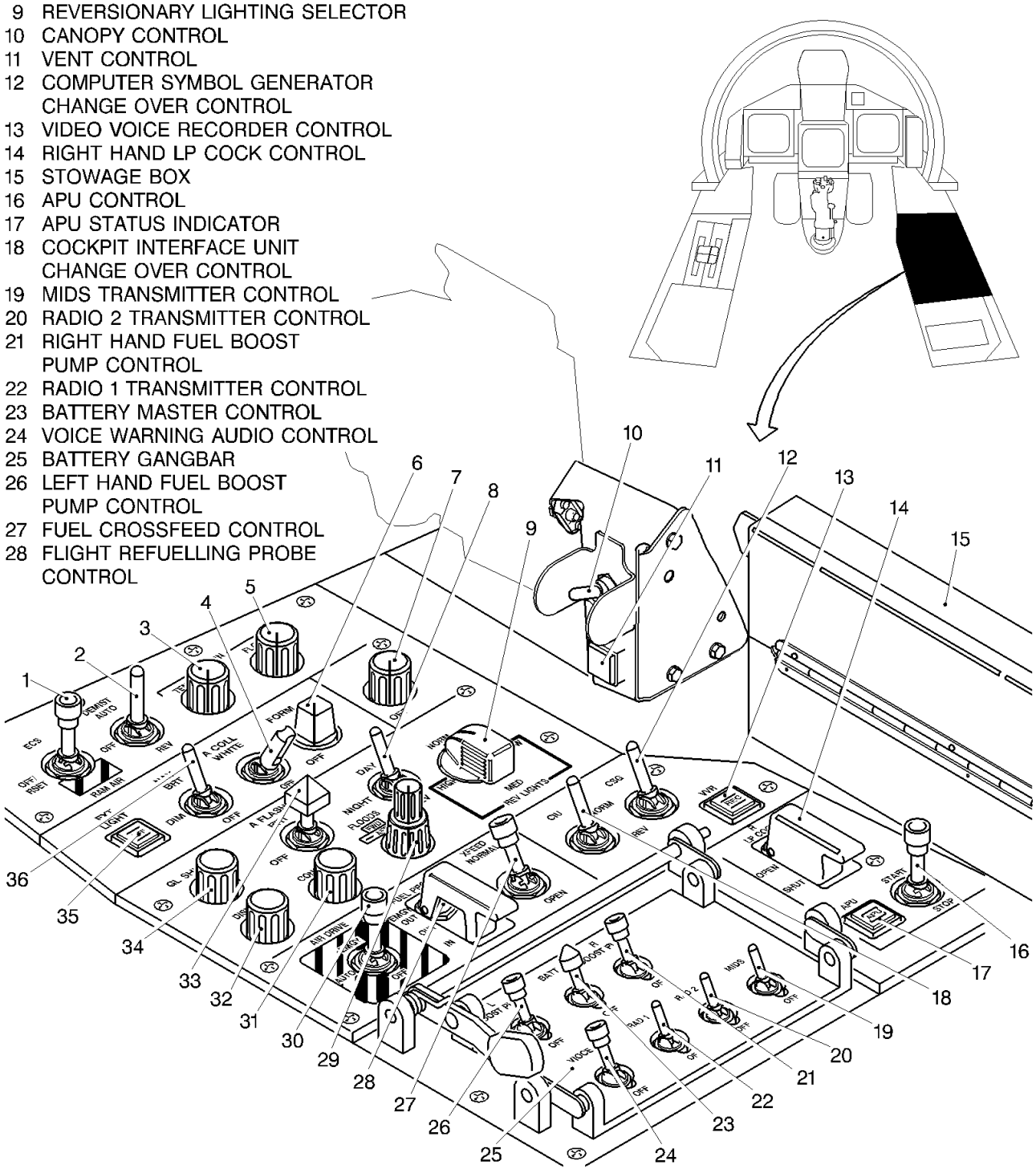


Figure 1.10 - Right Forward Console

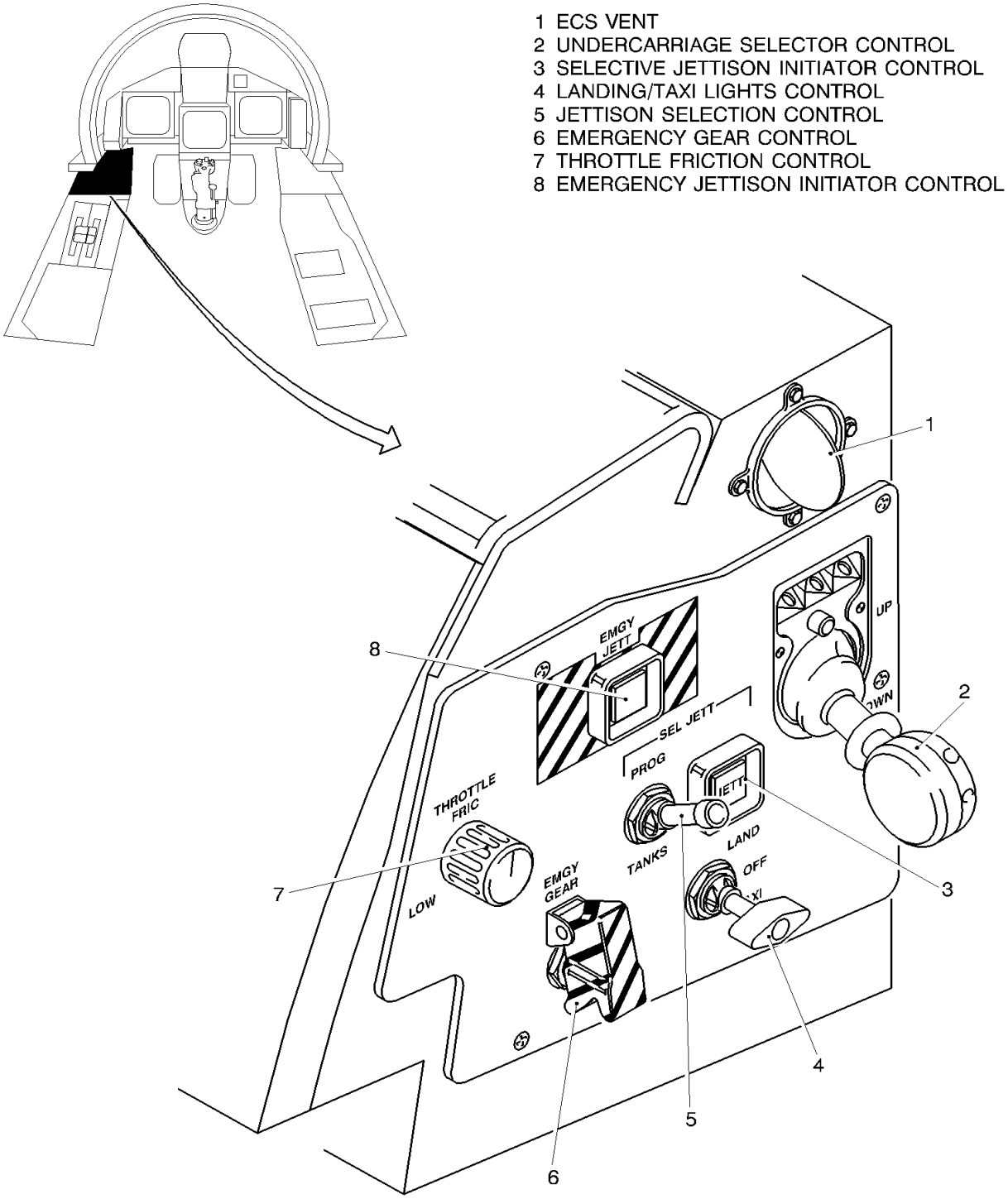


Figure 1.11 - Left Quarter Panel

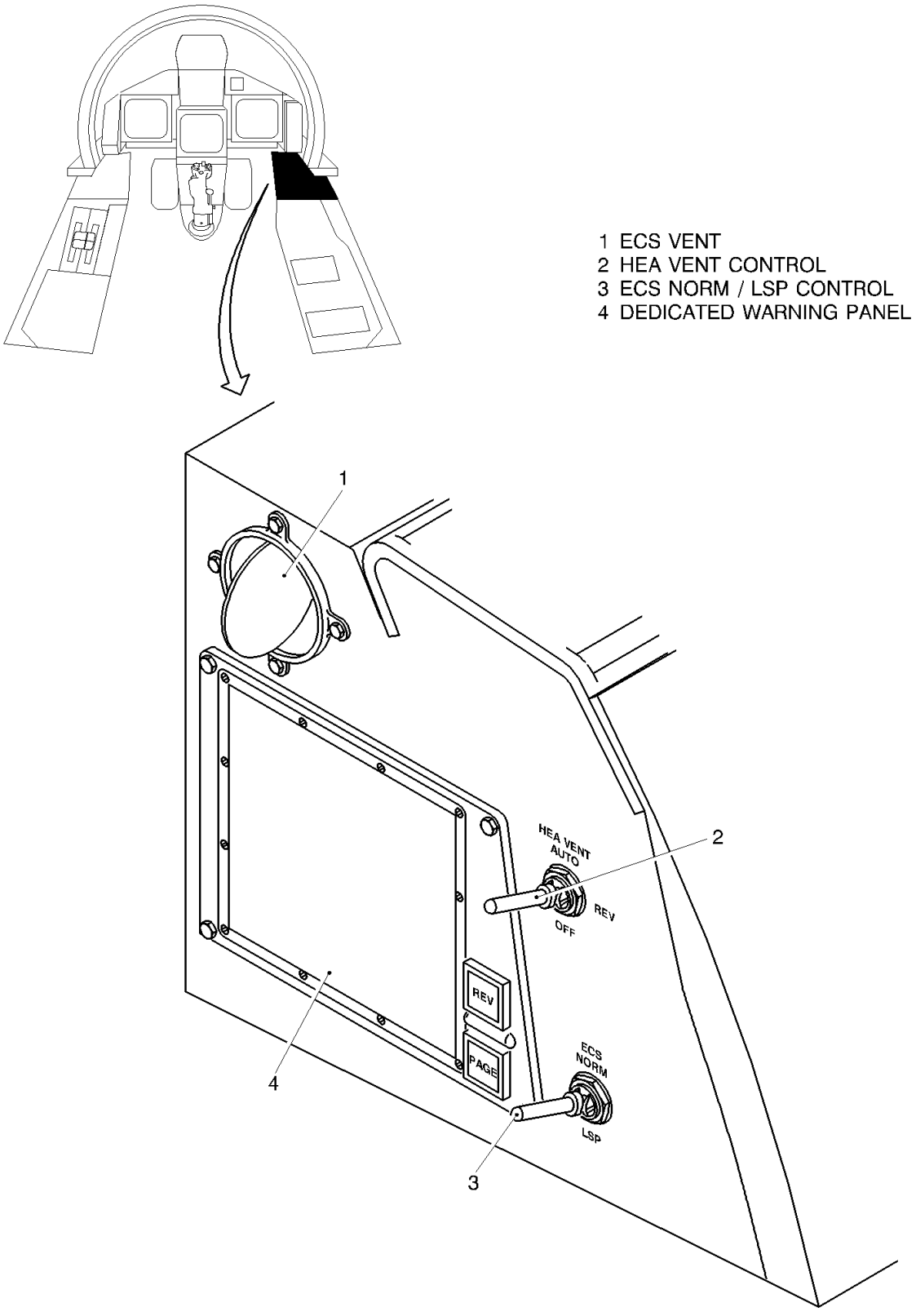


Figure 1.12 - Right Quarter Panel

1 ATTENTION GETTING DEVICE
2 MODING KEYBOARD
3 SUBSYSTEM KEYBOARD
4 BAROMETRIC PRESSURE SETTING CONTROL
5 SET WAYPOINT KEY
6 CHANGE DESTINATION KEY
7 DATA ENTRY KEYBOARD
8 READ OUT LINE DISPLAYS
9 MARKER TOGGLE CONTROL
10 SET WAYPOINT DISPLAY
11 DESTINATION WAYPOINT DISPLAY
12 BAROMETRIC PRESSURE SETTING DISPLAY
13 AUTOTHROTTLE/AUTOPILOT SELECTION CONTROL
14 AUTOPILOT MODE SELECTION DISPLAYS

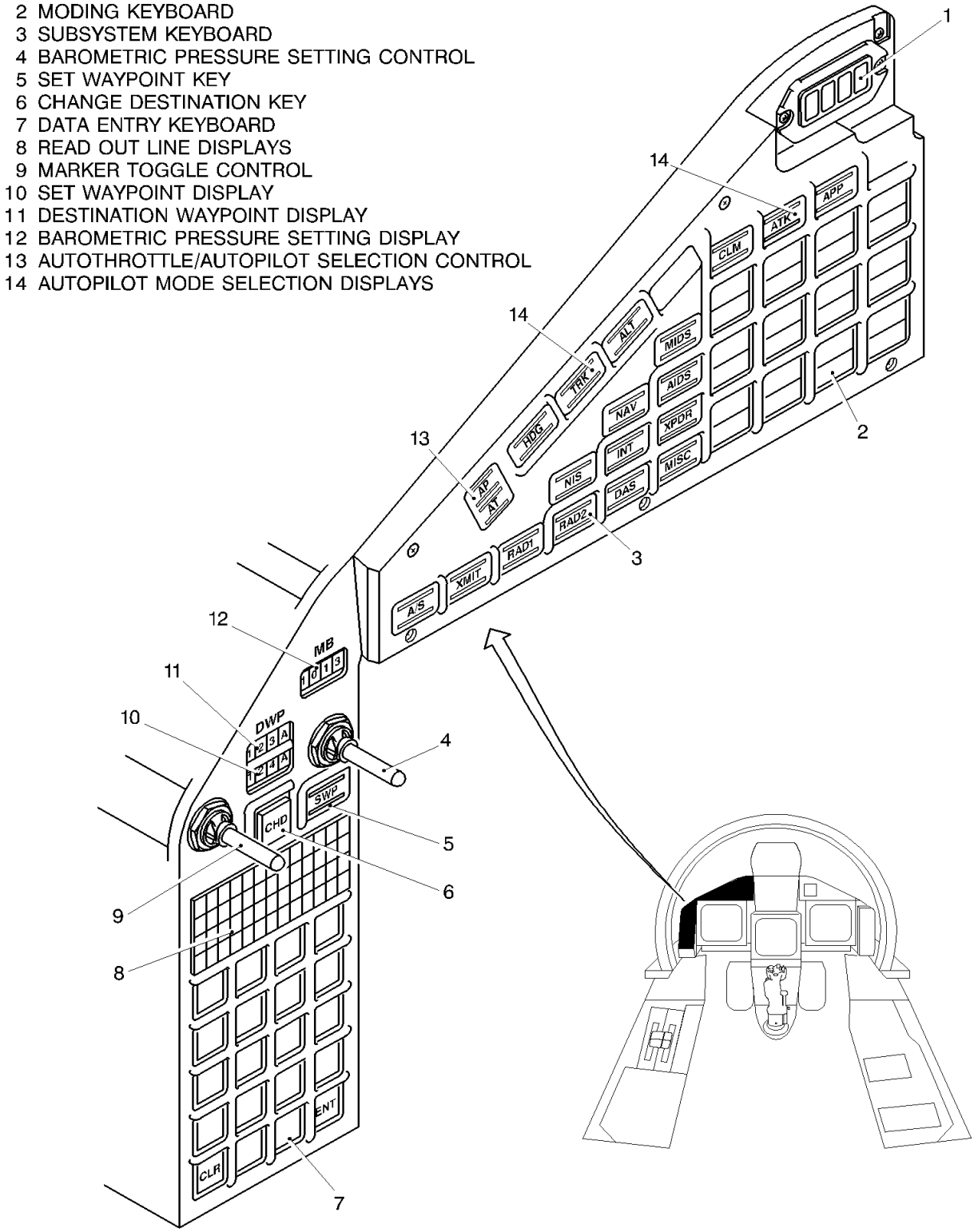


Figure 1.13 - Left Glareshield

1 DEDICATED READOUT PANEL
2 ATTENTION GETTING DEVICE
3 REVERSIONARY ATTITUDE INDICATOR
4 EMERGENCY AIRFIELD CROSS TRACK ERROR INDICATOR
5 RADAR ALTIMETER CLEARANCE HEIGHT SETTING CONTROL
6 REVERSIONARY AIRSPEED INDICATOR
7 REVERSIONARY ALTITUDE INDICATOR
8 REVERSIONARY VERTICAL SPEED INDICATOR
9 REVERSIONARY MACH NUMBER DISPLAY
10 RADAR ALTIMETER CLEARANCE HEIGHT SETTING DISPLAY
11 IDENTIFICATION RESPONSE SELECTION
12 TRANSPONDER EMERGENCY CONTROL
13 RANGE TO EMERGENCY AIRFIELD DISPLAY
14 SLIP INDICATOR
15 EMERGENCY AIRFIELD DESIGNATOR CODE DISPLAY
16 REVERSIONARY ANGLE OF ATTACK INDICATOR

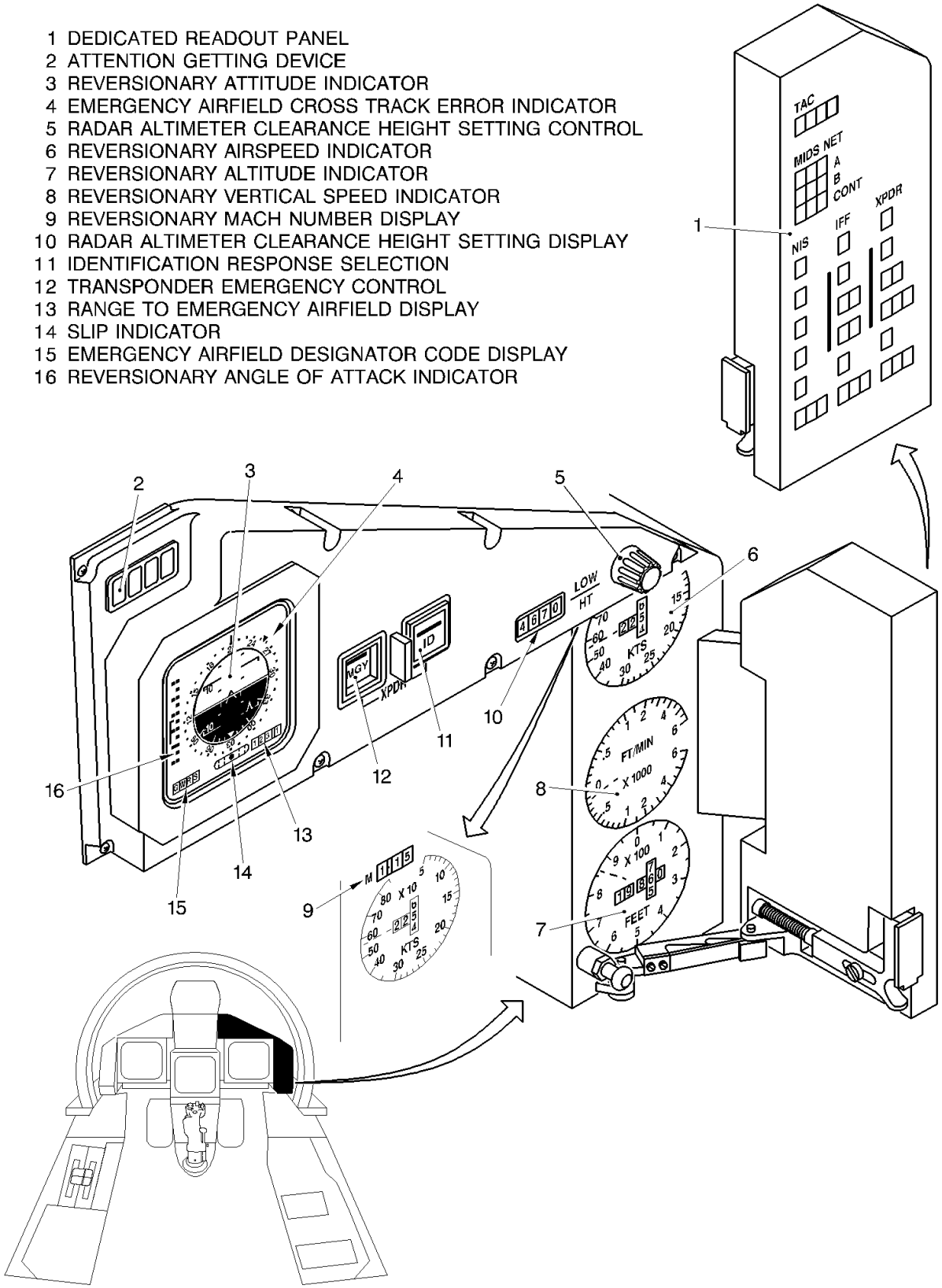
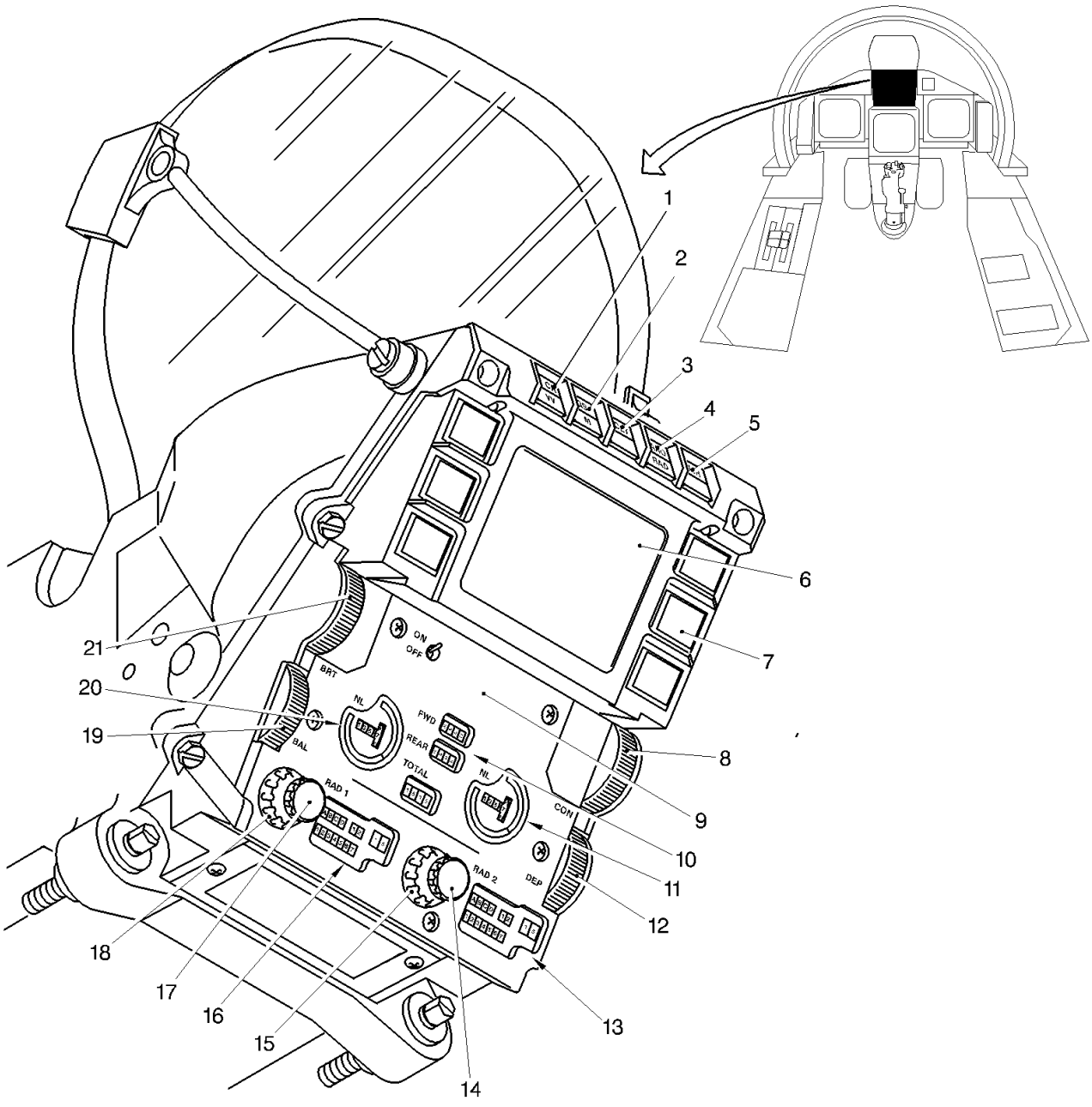


Figure 1.14 - Right Glareshield



1 HUD AIRCRAFT SYMBOL MODE CONTROL
2 HUD GROUNDSPEED/MACH DISPLAY SELECTOR
3 HUD DE-CLUTTER LEVEL SELECTOR
4 HUD RAD ALT/BARO ALT SELECTOR
5 HUD FLIR DISPLAY SELECTOR
6 MIDS DISPLAY
7 MIDS PUSHBUTTON CONTROLS
8 RASTER GAMMA CONTROL
9 HUD POWER CONTROL
10 FUEL READOUT DISPLAYS
11 RIGHT HAND ENGINE NL DISPLAY
12 DEPRESSION SETTING CONTROL
13 RADIO 2 READOUT DISPLAYS
14 RADIO 2 CHANNEL SELECTOR
15 RADIO 2 VOLUME CONTROL
16 RADIO 1 READOUT DISPLAY
17 RADIO 1 CHANNEL SELECTOR
18 RADIO 1 VOLUME CONTROL
19 HUD RASTER/CURSIVE BALANCE CONTROL
20 LEFT HAND ENGINE NL DISPLAY
21 HUD PDU LUMINANCE CONTROL

Figure 1.15 - Head Up Display Control Panel

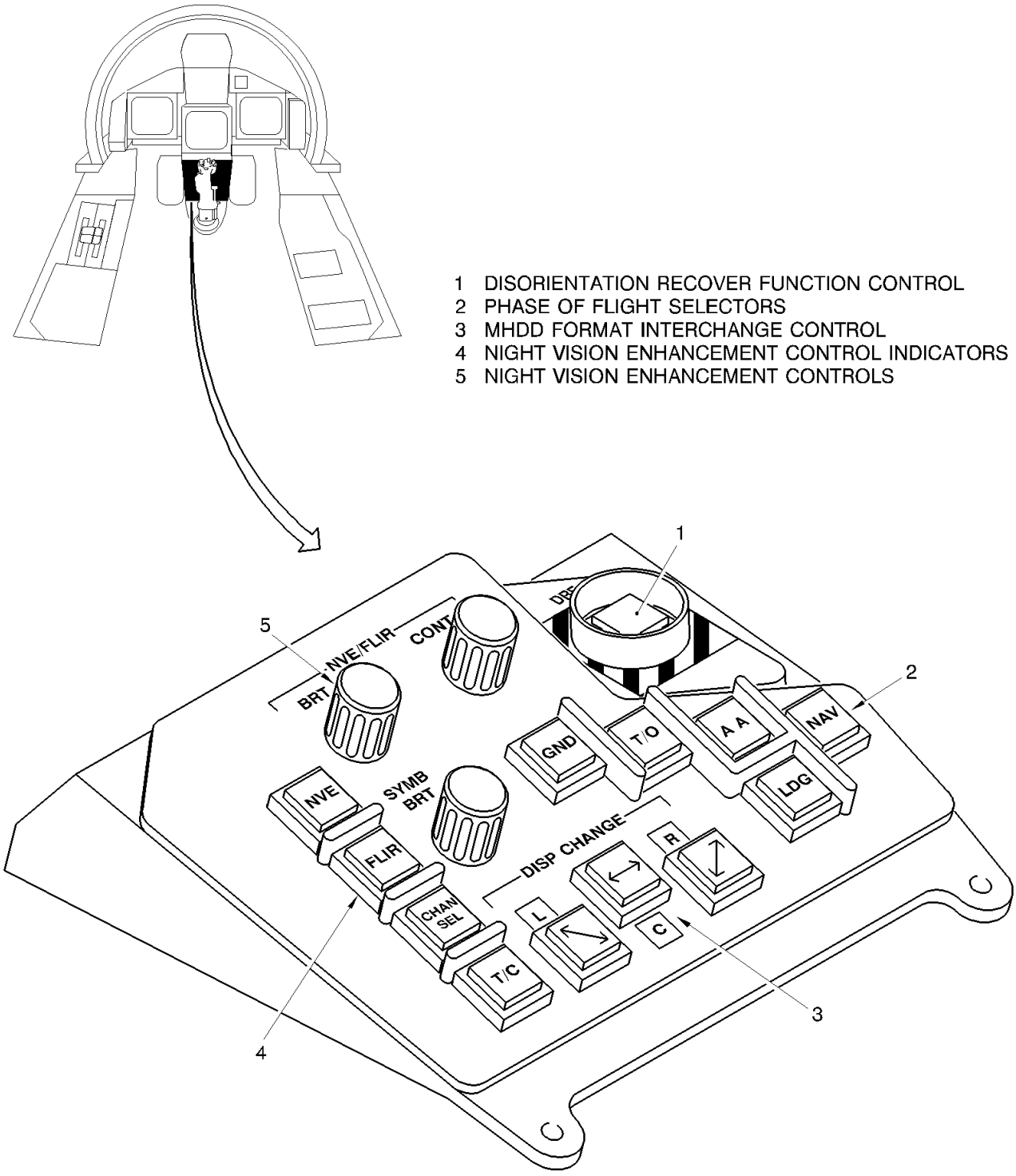
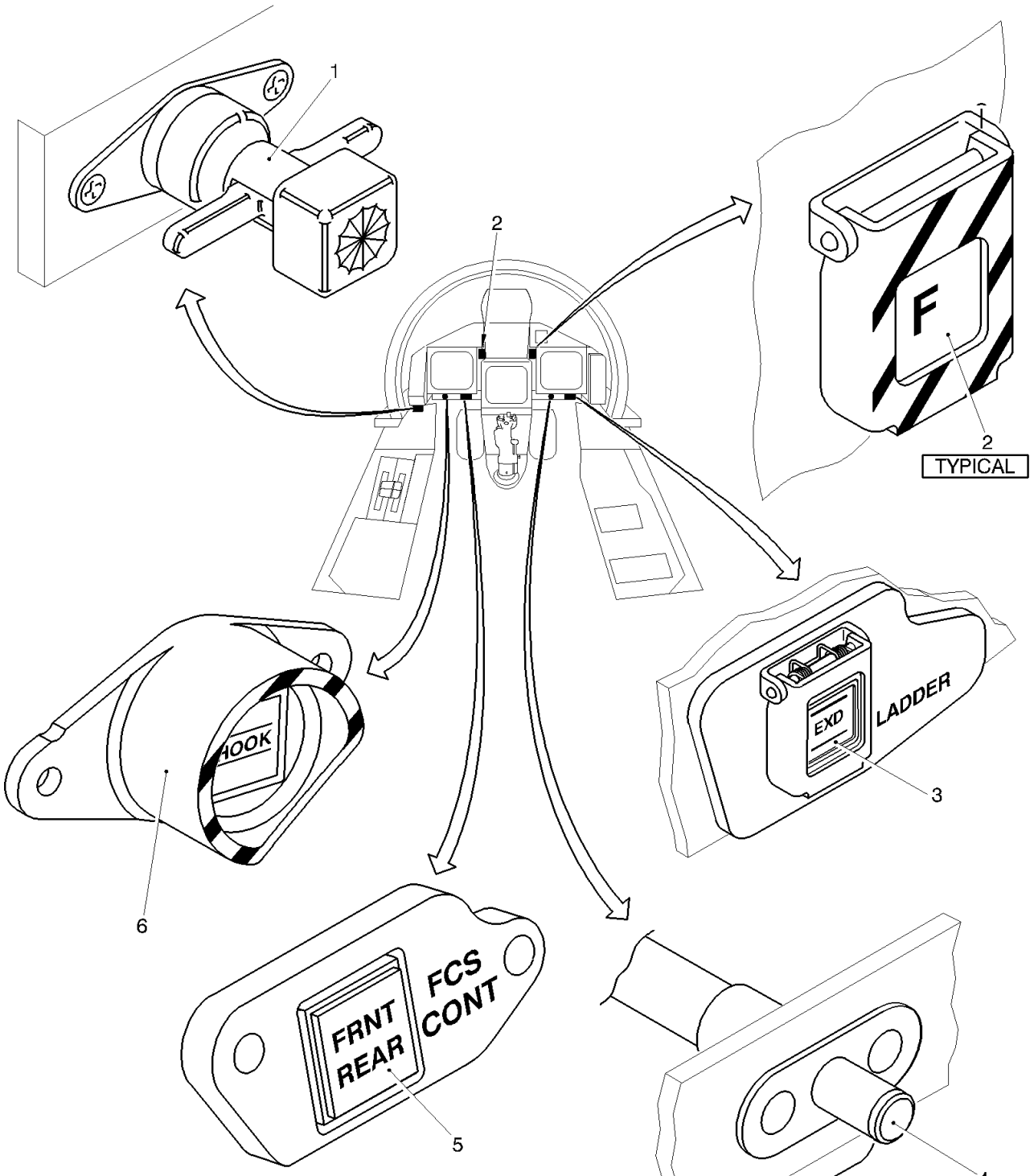


Figure 1.16 - Pedestal Panel



1 BRAKE PARACHUTE RELEASE HANDLE
2 FIRE WARNING PUSHBUTTON SELECTOR/INDICATOR (2)
3 LADDER EXTENDED INDICATOR
4 PEDAL ADJUSTMENT CONTROL
5 FLIGHT CONTROL SYSTEM CONTROL
6 ARRESTER HOOK DEPLOYMENT CONTROL

Figure 1.17 - Miscellaneous Controls

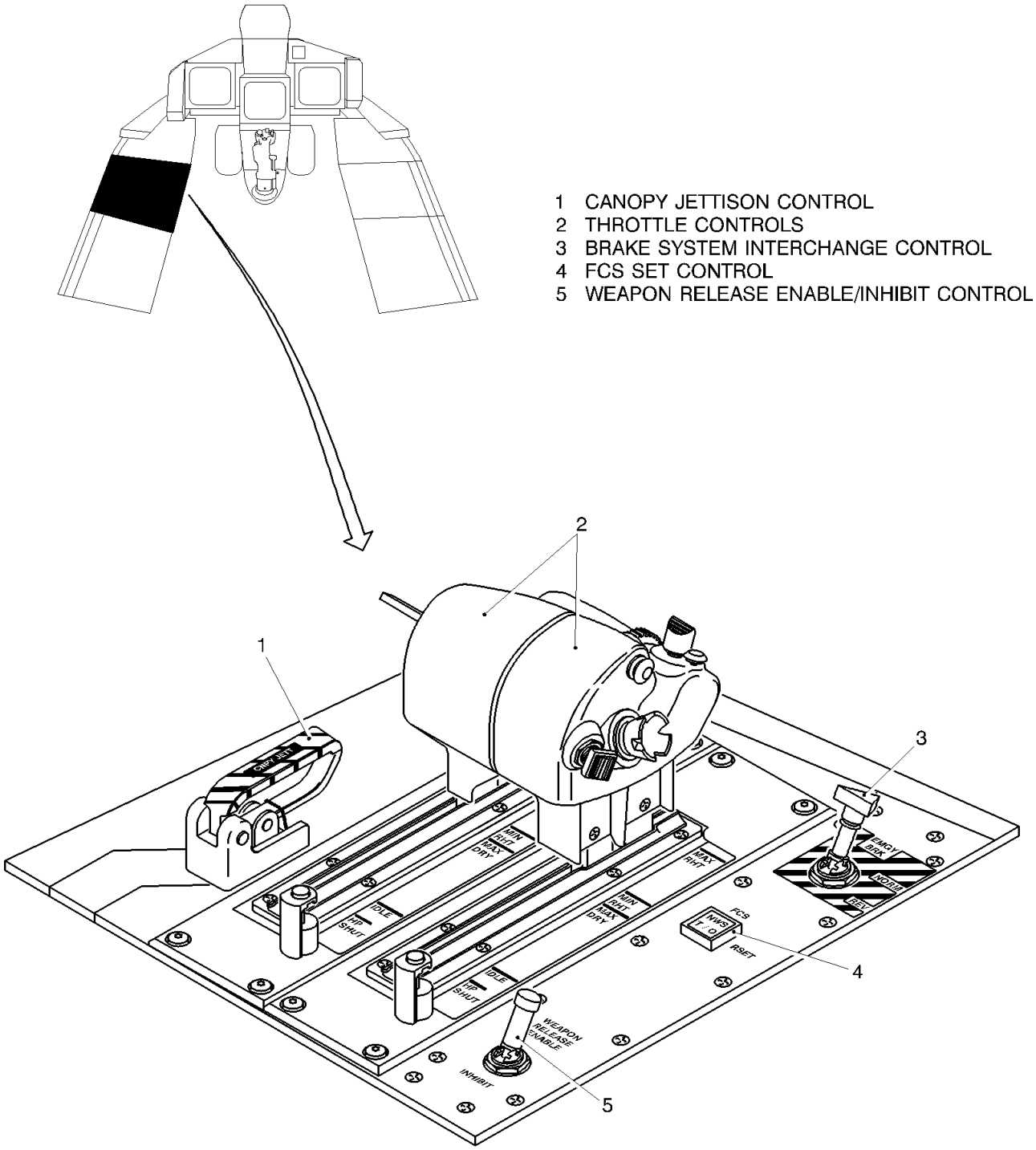


Figure 1.18 - Rear Cockpit Left Forward Console

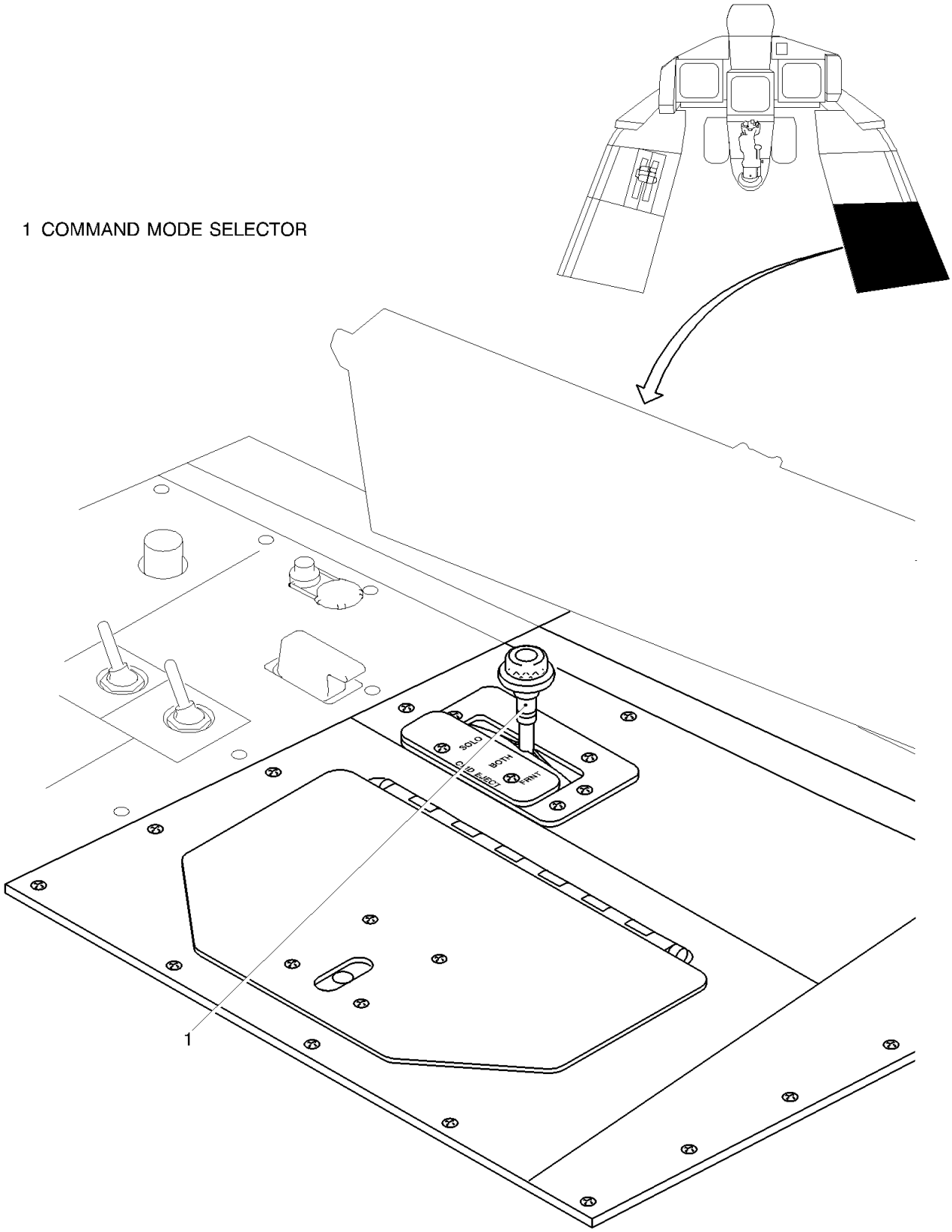


Figure 1.19 - Rear Cockpit Right Rear Console

1 GLARESHIELD ZONE LUMINANCE CONTROL
2 ANTIFLASH CONTROL
3 FWD/AFT FLOODLIGHT LUMINANCE CONTROL
4 LIGHTING SYSTEM MODE CONTROL
5 REVERSIONARY LIGHTING SELECTOR
6 SUIT TEMPERATURE CONTROL
7 EJECTION SEAT SAFETY PIN STOWAGE
8 RIGHT HAND LOW PRESSURE COCK CONTROL
9 HEAD EQUIPMENT ASSEMBLY CONTROL
10 REAR COCKPIT INTERFACE UNIT CHANGE OVER CONTROL
11 AUXILIARY POWER UNIT STATUS INDICATOR
12 PNEUMATIC DRIVE MASTER CONTROL
13 CONSOLE ZONE LUMINANCE CONTROL
14 MAIN DISPLAY ZONE LUMINANCE CONTROL

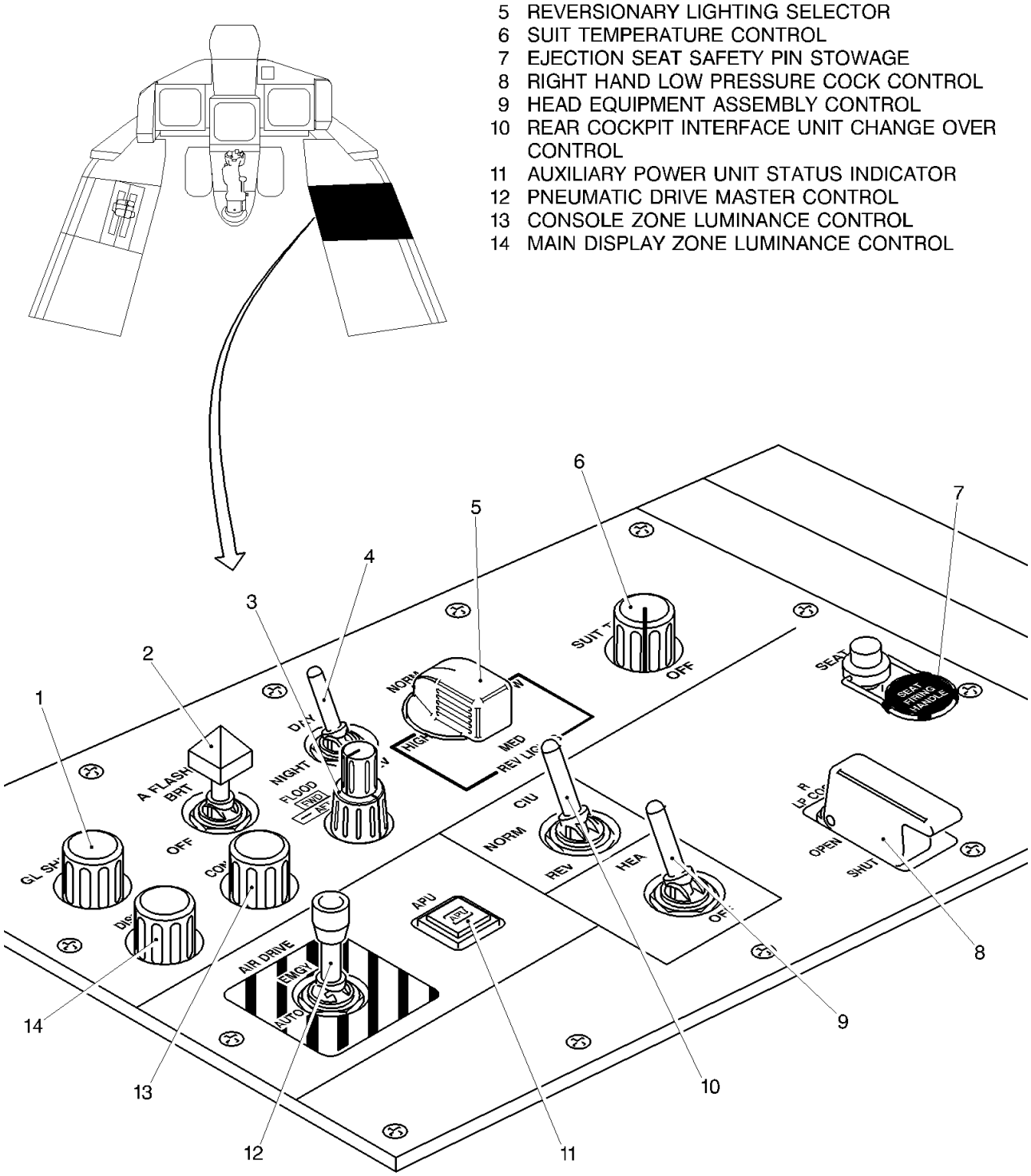


Figure 1.20 - Rear Cockpit Right Forward Console

1 ECS VENT
2 EMERGENCY JETTISON INITIATOR CONTROL
3 LANDING GEAR INDICATORS
4 SELECTIVE JETTISON INITIATOR CONTROL
5 EMERGENCY GEAR CONTROL
6 BRAKE PARACHUTE RELEASE HANDLE
7 THROTTLE FRICTION CONTROL

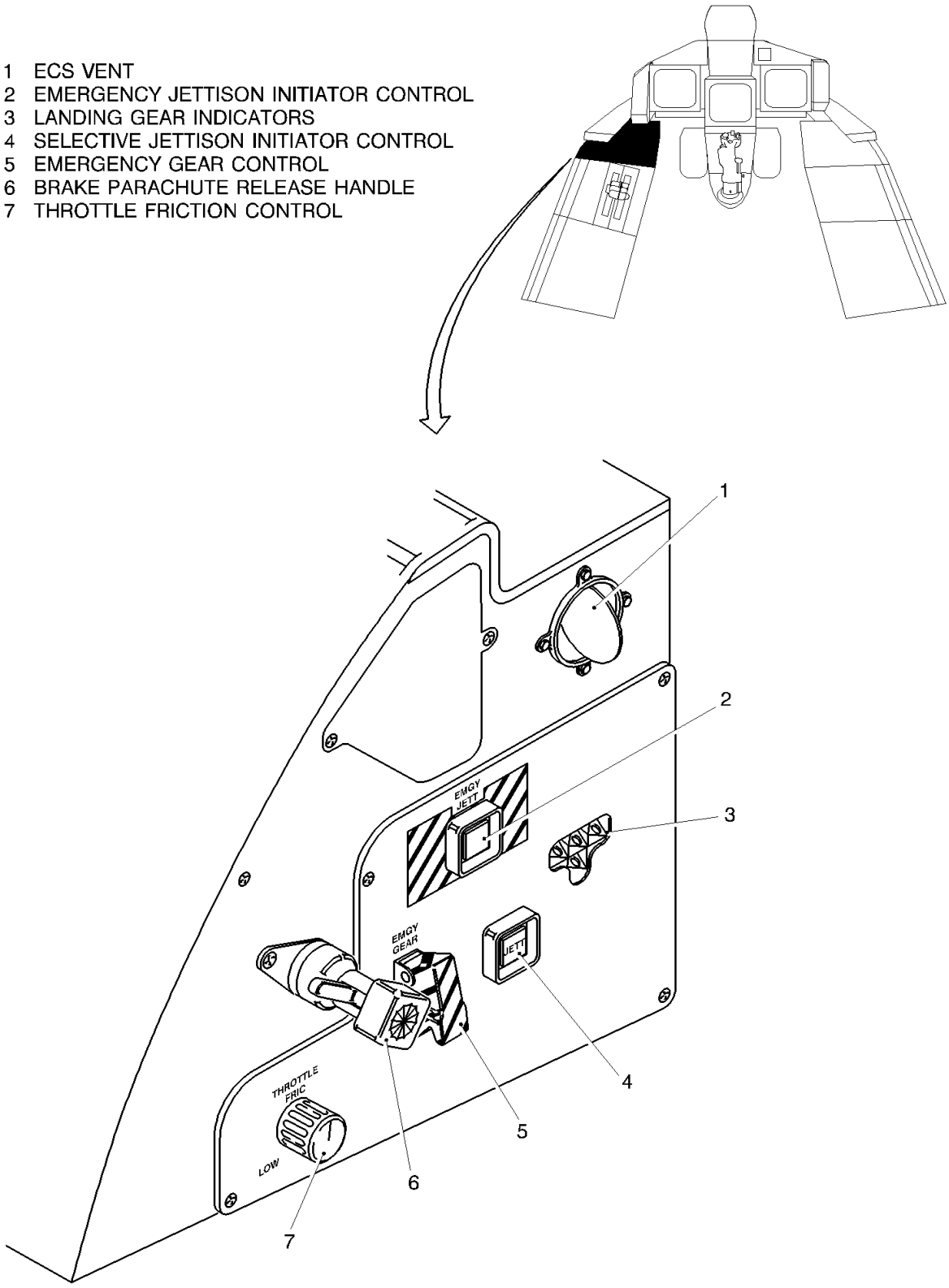


Figure 1.21 - Rear Cockpit Left Quarter Panel

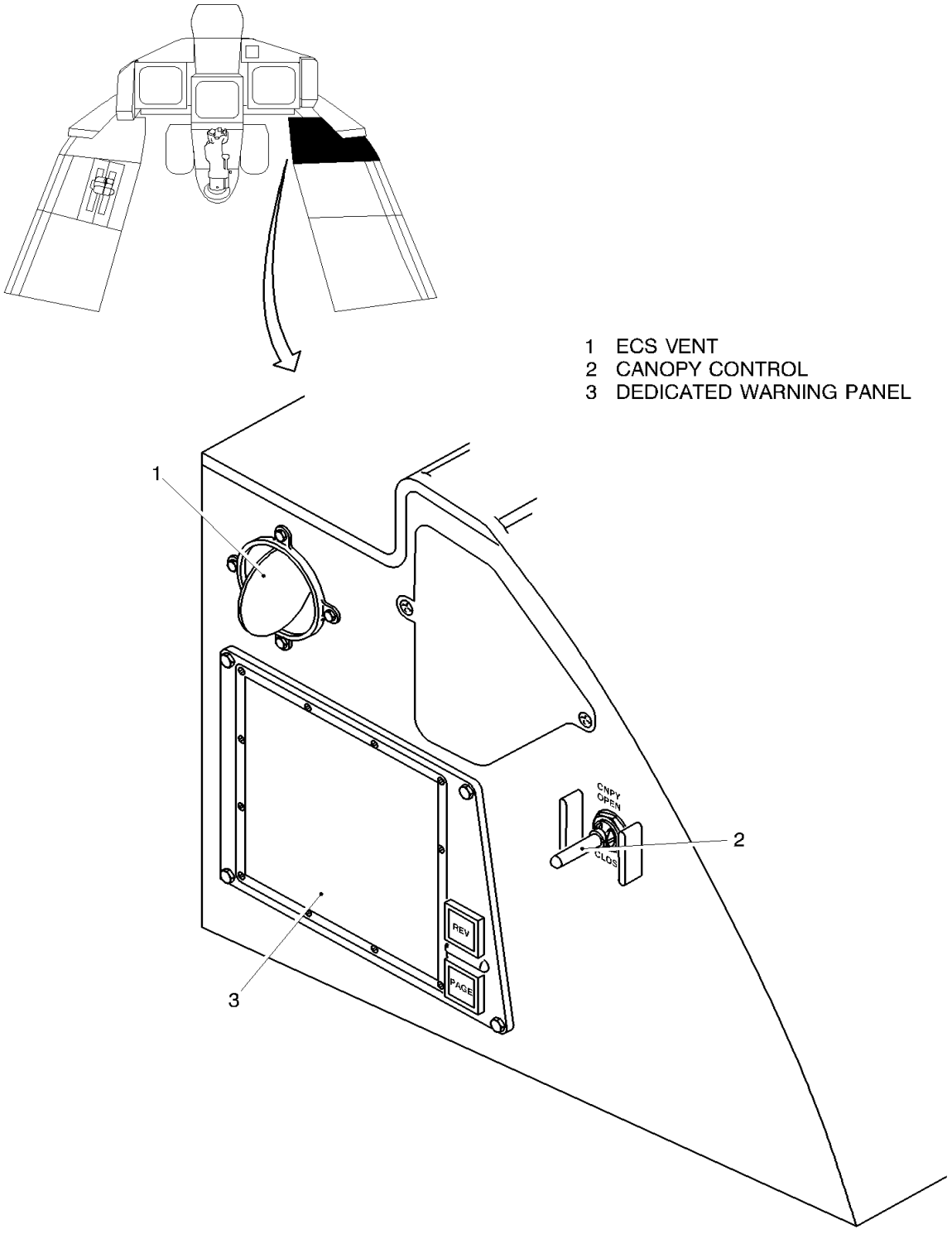


Figure 1.22 - Rear Cockpit Right Quarter Panel

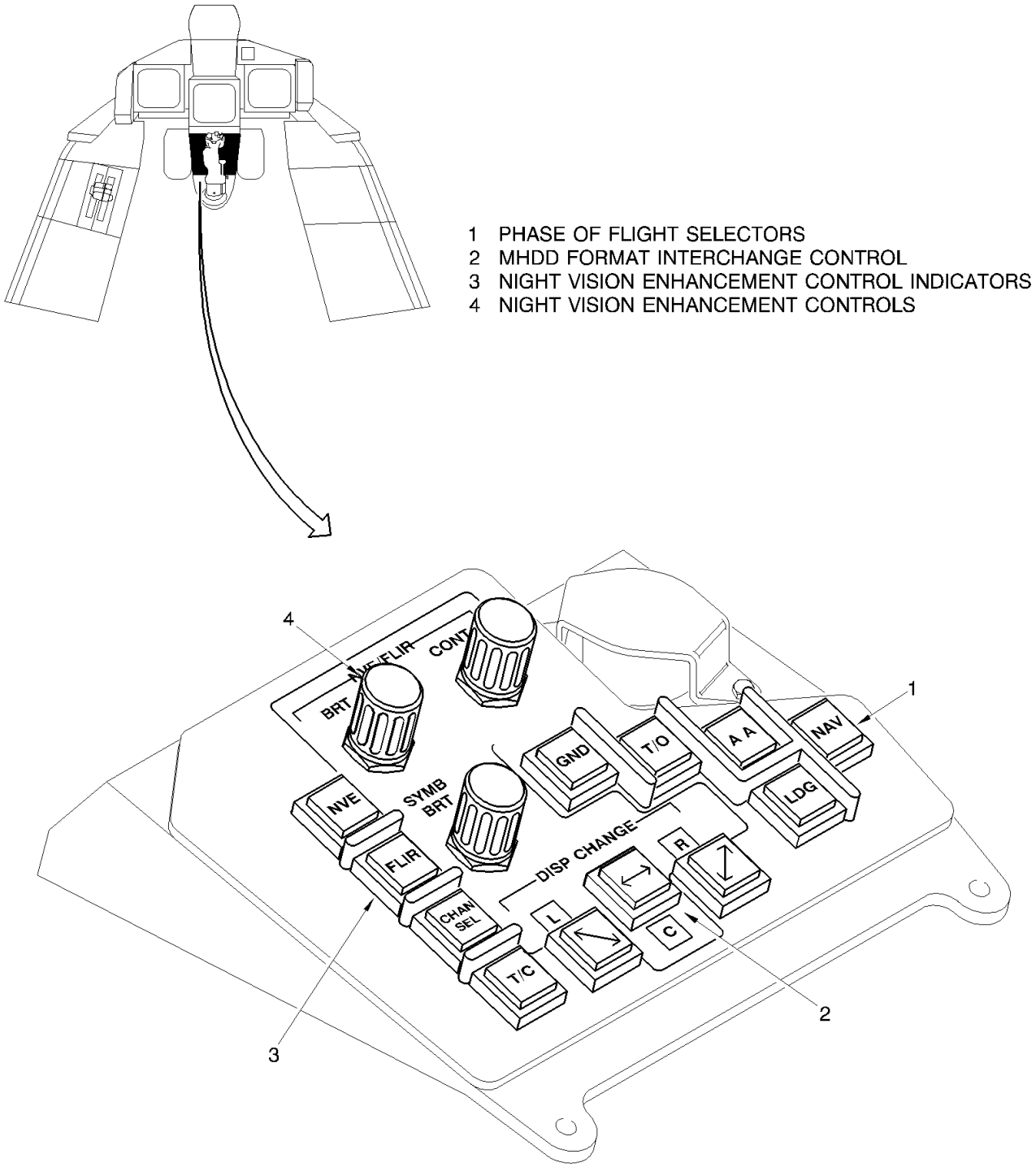
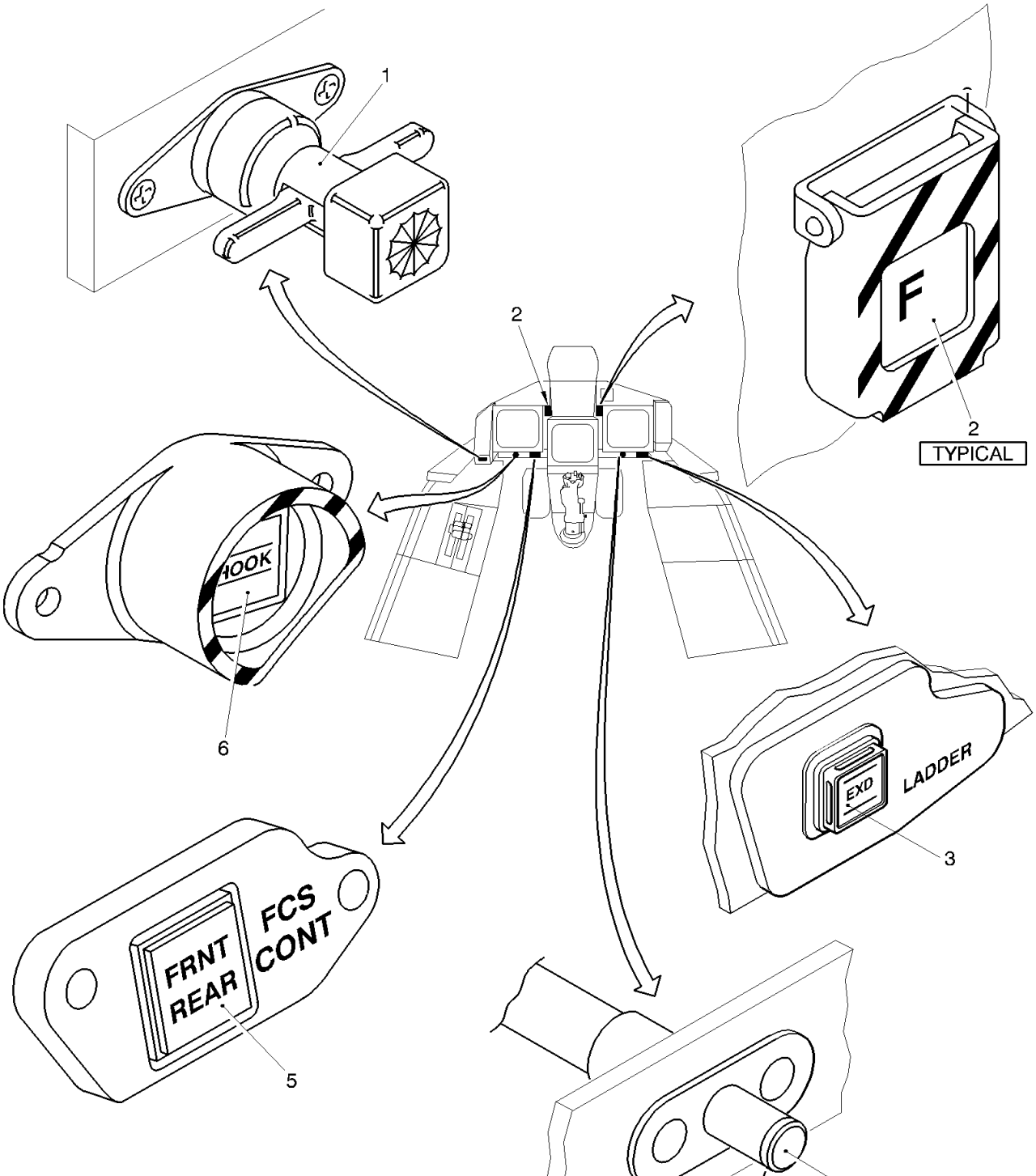


Figure 1.23 - Rear Cockpit Pedestal Panel



1 BRAKE PARACHUTE RELEASE HANDLE
2 FIRE WARNING INDICATOR (2)
3 LADDER EXTENDED INDICATOR
4 PEDAL ADJUSTMENT CONTROL
5 FLIGHT CONTROL SYSTEM CONTROL
6 ARRESTOR HOOK DEPLOYMENT CONTROL

Figure 1.24 - Rear Cockpit Miscellaneous Controls

General Electronic Displays

(1B-B-31-10-00-00A-111A-A Issue 003)

Introduction

Integration of the aircraft systems is achieved by using electronic displays and controls, Figure 1.25 and Figure 1.26 . The main integrated displays and controls are as follows:

– Head up Display (HUD)
– Multifunction Head Down Display (MHDD)
– Dedicated Warnings Panel (DWP)
– Manual Data Entry Facility (MDEF)
– Dedicated Readout Panel (DRP)
– HOTAS facility.

Head up Display

The HUD comprises a Head up Panel (HUP) and PDU. It is a flight instrument which projects flight information into the aircrew's FOV. The HUP contains the controls associated with the display of information on the PDU and a Multifunction Information Distribution System (MIDS) display with associated controls (not yet in use). The panel also displays information on fuel status, engine speed and radios. The brightness, contrast and balance of the display on the PDU can be adjusted using thumb-wheel controls. For more information refer to Head up Display pag. 1-34.

Multifunction Head down Display

The MHDD enable information on the status of the aircraft systems to be displayed. The appropriate displays will automatically be selected upon selection a POF control on the pedestal panel. The orientation of these displays may be changed from the default by use of the display change keys also on the pedestal panel.

NOTE

All other pedestal panel controls, with the exception of disorientation recovery, are for use with the Helmet Mounted Symbology System (HMSS), which is not yet available.

Each MHDD comprises a color display, capable of displaying data in raster, cursive or raster/cursive format. The main display area is surrounded by a bezel containing 17 soft-keys, rotary controls for and HSI heading/course (Pilot Awarness format) and radar/map balance (Attack format), rocker switches for brightness and contrast, and two ambient light sensors. For more information refer to Multifunction Head down Display pag. 1-60.

Dedicated Warnings Panel

The DWP indicates aircraft system malfunctions on a reconfigurable dot matrix display. This display is capable of presenting 27 captions simultaneously, in three columns of nine. The bottom row of captions are hard wired and display one fixed warning each. For more information refer to Dedicated Warning Panel pag. 1-432.

Manual Data Entry Facility

The MDEF contains data entry, subsystem and moding keys, switches and ROL. These provide subsystem control and allow inputs or updates to various subsystem data. For more information refer to Manual Data Entry pag. 1-92.

Dedicated Readout Panel

The DRP displays information concerning the IFF transponder (XPDR) and TACAN in ROL form. It will also provide MIDS net information (facility not yet available).
The panel is hinged on the outboard side of the right glareshield allowing access to the reversionary GUH instruments when required. For more information refer to Get-U-Home Instruments pag. 1-113.

HOTAS Facility

Controls located on throttle and stick top enable the aircrew to perform weapon system moding and sensor control without the removal of hands from the flying controls. For more information refer to Hands on Throttle and Stick pag. 1-107.

Reversionary Aircraft Situation Display

The reversionary aircraft situation display provides the aircrew with a cross track error (to emergency airfield), attitude, slip and AOA indication for use under reversionary conditions. For more information refer to Get-U-Home Instruments pag. 1-113.

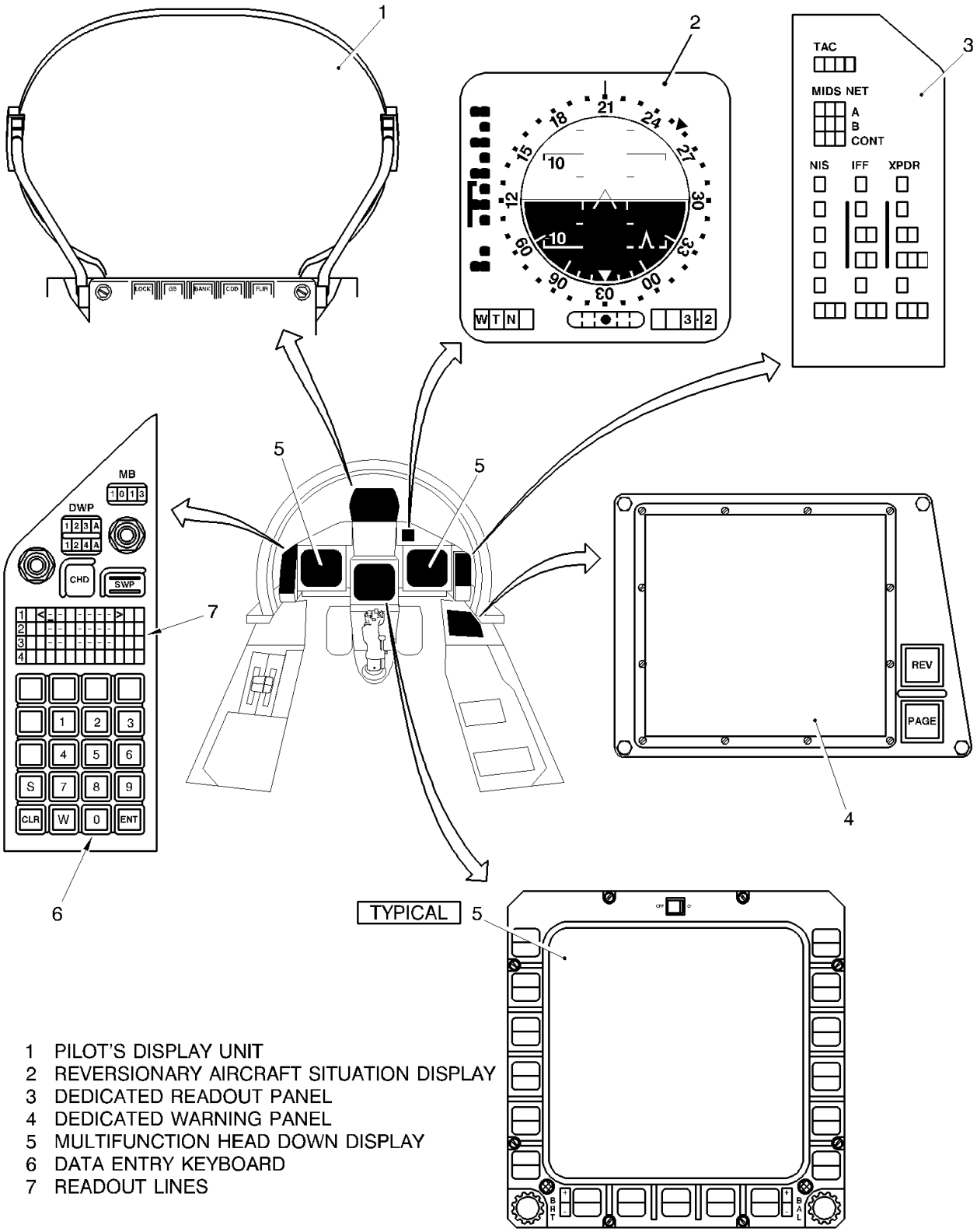


Figure 1.25 - General Cockpit Displays

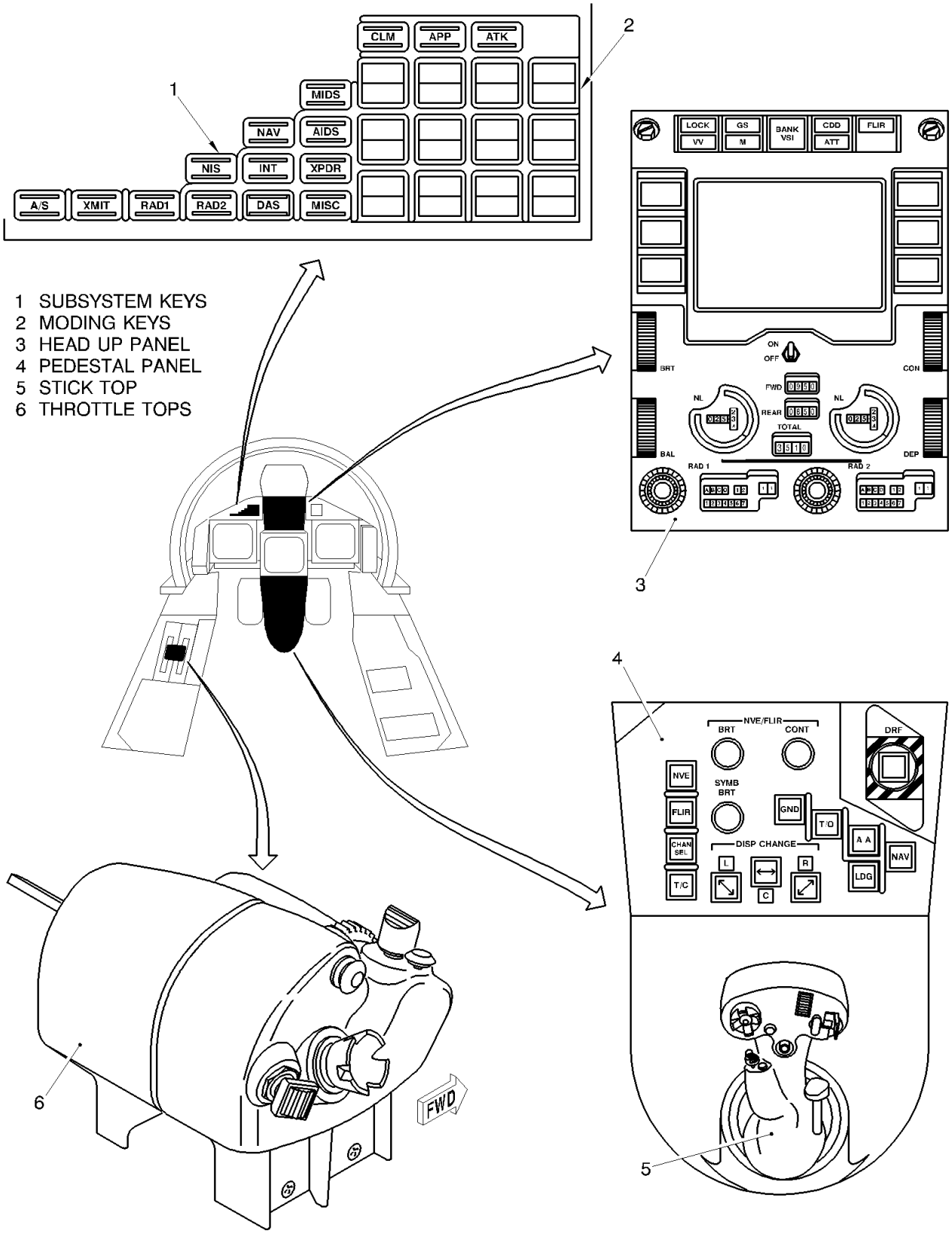


Figure 1.26 - General Cockpit Controls

Head up Display

(1B-B-31-14-00-00A-043A-A Issue 002)

Introduction

The HUD is a flight instrument which projects flight and weapons delivery information into the pilot's FOV. The information presented assists the pilot to manually steer the aircraft during normal flight and during the attack POF. The symbols are generated by one of two Computer Symbol Generators (CSG) and are focused at infinity, allowing the display to be followed in elevation and azimuth with limited head movement. Provision is made for the selection or exclusion of certain symbology appropriate to the current flight mode.

NOTE

The pilot shall cross-monitor the HUD and other onboard instruments at appropriate intervals.

Upon switch-on (but before normal operation begins) an internal start-up BIT is automatically initiated but no test patterns are generated. During operation, a continuous BIT monitors certain HUD functions.

If both CSG or the AC power supply fail, the HUD format will not be displayed but the DC driven controls and indicators on the Head up Panel (HUP) function as normal.

If the DC power supplies to the HUD fail, the battery supported displays and controls on the HUP will remain operable for a limited period.

In addition, if the HUP fails, Radio 1 and 2 can be controlled via the left glare shield.

Construction

The HUD includes the following subassemblies:

– PDU
– HUP
– HUD video camera
– HUD mounting tray.

Pilot's Display Unit

The PDU comprises an optical assembly plus mechanical and electrical assemblies that combine to project information to the pilot. The PDU is positioned such that the combining glass is in the pilot's LOS and is not obscured.

Two light sensors mounted on the top of the PDU monitor the ambient light conditions to maintain the contrast level of the display.

Head up Panel

The HUP is located immediately below the PDU and contains the controls and indicators associated with the HUD. For information on the associated controls and indicators see Head up Display pag. 1-57.

HUD Video Camera

The HUD video camera enables the recording of the 'outside world', as seen through the combiner assembly. The output of the video camera is routed to the selected CSG, where the HUD symbology is added. The result is a view of the 'outside world' with HUD symbology superimposed upon it.

HUD Mounting Tray

The HUD mounting tray enables the ground crew to harmonize the PDU with the airframe by adjusting four mounting tray adjusting studs.

HUD Symbology

HUD symbology consists of:

– Attitude/directional reference symbology
– Airdata symbology
– Autopilot symbology
– Navigation symbology
– Air to air attack symbology
– Miscellaneous symbology.

Attitude/Directional Reference Symbology

Attitude/Directional Reference Symbology is shown in Figure 1.27 and Figure 1.29 .

The climb/dive symbol is a winged circle which provides aircraft directional reference whilst the system is operating in climb/dive mode. The symbol has two modes of operation; locked (LOCK) and Velocity Vector (VV). These modes are controlled by the LOCK/VV selector/indicator on the HUP. In LOCK, the aircraft symbol is locked to the vertical axis of the HUD (indicated by a radial flag at the 12 o'clock position on the circle) and can be adjusted using the depression setting control on the HUP. When in VV, the symbol is referenced to the aircraft velocity vector in elevation between +5° and -15° with respect to the LFD.

NOTE

The VV symbol does not move in azimuth.

A diamond indicates the aircraft's velocity vector. Full freedom of movement extends to the limit of the HUD FOV, where it parks and flashes at the FOV edge.

The attitude symbol replaces the climb dive symbol if airspeed falls below 48kt to indicate aircraft pitch attitude instead of climb/dive angle.

Aircraft climb dive angles and roll attitude, relative to the aircraft symbol are displayed by a horizon bar, climb/dive bars and zenith and nadir stars. Climb/ dive is displayed in the form of a tapered ladder with incremental steps of 5°, from 0° up to 30°, and steps of 10°, from 30° to 80°. The climb/dive symbology is displayed at a ratio of 1:1 to the real world from 0 to 5°. Thereafter the ratio increases at a nonlinear rate reaching a maximum of 4.4:1 at 90°. In roll the display has 360° movement around the aircraft symbol.

The bank/roll pointer is an infilled triangular pointer which is rotated around a fixed bank scale to indicate current bank angle. The scale covers the range 0° to 60° with graduation marks at the 10°, 20°, 30° and 60° positions.

The Specific Excess Power (SEP) markers consist of two arrow heads, displayed at each side of the aircraft symbol. The displacement between these arrow heads and the aircraft symbol indicates the angle at which the aircraft should climb or dive to achieve a constant speed. When the aircraft symbol is bracketed by the SEP markers a constant speed is indicated. The markers provide an indication of climb performance, energy loss/available in turns and are useful for speed control in precision flying.

The pull up arrow alerts the pilot to pull up. The action is indicated by a flashing arrow, which rotates about its centre point such that it always points away from the ground. The command ‘PULL UP’ is shown boxed below the arrow.

Miscellaneous Symbology

Miscellaneous symology is shown in Figure 1.28 and Figure 1.29.

Stopwatch count up presents an increasing time interval in hours, minutes and seconds. Whilst countdown presents a decreasing time interval in hours, minutes and seconds. Upon reaching ‘0’ the digits flash for 5 seconds. Split time for the count up or countdown stopwatch may be indicated. When the split time is displayed the stopwatch continues to run.

Undercarriage state is presented on the left of the display. One of three legends is displayed to indicate the state of each landing gear leg. Gear up and locked is indicated by ‘UP’, gear down and locked is indicated by ‘D’ and gear in transit is indicated by ‘X’. The landing gear status is displayed whenever the gear is locked down or in a state of transition. Gear status is displayed for a further 10 seconds when the gear is declared up and locked.

An indication of depression angle is provided by a digital readout to a resolution of 0.1°; the angle is set by the rotary depression setting control on the HUP. The depression angle is the displacement of the aircraft symbol from the LFD during lock mode, The new value (0 to -15°) is displayed for 5 seconds following any change to the depression angle setting.

The airbrake indicator is shown against the aircraft symbol when the airbrake is in any position other than closed and locked.

‘LATE ARM SAFE’ is displayed to indicate that the late arm control is set to the safe condition.

‘GEAR’ is displayed to indicate that the undercarriage limiting speed of 290kt has been exceeded and that the gear must be raised.

‘XFER’ is displayed to Indicate that manual fuel transfer is in progress.

‘AUTO RECOVERY’ is displayed to Indicate that the automatic recovery mode is enabled.

Acknowledgement of Direct Voice Input (DVI) command recognition is provided by a boxed 34 character text string. DVI is activated when the HOTAS communciations control button is pressed and held.

Airdata Symbology

The symbology associated with airdata is shown in Figure 1.30 , Figure 1.31 and Figure 1.34.

The barometric altitude display comprises an analogue and a digital display (up to five digits), surrounded by a circular scale of 10 dots and a rotating pointer. The pointer rotates once per 1000ft. Display resolution is in 20ft increments at, or below 5000ft, increasing to 50ft increments above 5000ft.

Displayed airspeed is presented digitally on the left of the display to a resolution of 1kt. Ground speed or Mach number can be selected via the GS/M selector/ indicator, on the HUP. With weigh off wheels, the Mach number is displayed automatically when Mach number exceeds M0.9.

NOTE

Between M1.0 and M1.2 DAS is a combination of aircraft CAS and EAS. However, when the Mach number is less than M1.0, DAS is sourced from CAS only, and when it is greater than 1.2 DAS it is sourced from EAS only.

AOA is indicated by a small scale which moves against the aircraft symbol to indicated incidence during the take off and landing POF. The scale has three horizontal markers: an upper marker representing 16°, a middle marker representing 14° and a lower marker representing 12°.

The vertical velocity scale on the right of the display is indicated in ft/min. The display comprises a triangular pointer that moves against a fixed scale

with an ‘elastic’ line connecting the pointer to the zero marker on the scale. The display covers the range -2000ft/min to +2000ft/min and is marked at ±500ft/min, ±1000ft/min and ±2000ft/min. If the scale limits are exceeded the pointer rotates upwards or downwards.

Barometric pressure is set via the left glare shield. Following any change to this setting the new value is displayed on the HUD for 5 seconds as a four digit readout.

Normal g is displayed along side the energy cue (Figure 1.31), unless in ground POF when the readout is occulted. Normal g is displayed to a resolution of 0.1g.

The energy cue indicates AOA and speeds required for optimum aircraft performance. A speed scale provides a reference to relate the energy cue symbols against. The energy cue is available in the navigation, combat and air to surface POF. The energy cue symbols provide the following:

– An indication of maximum and minimum speed, via the speed scale
– An indication of the AOA for the maximum STR at current speed
– An indication of current AOA (+30° to -5°). The caret symbol can be displayed -5° below the minimum marker on the speed scale
– An indication of the AOA required to achieve maximum acceleration
– An indication of the current speed, via a marker which moves between the maximum and minimum speed markers
– An indication of the speed trend, ie, the predicated speed in 5 seconds time. The length is limited to a maximum of 30kt/sec and grows either up or down from the current speed symbol
– An indication of the speed required for the maximum Sustained Turn Rate (STR)
– An indication of the lowest speed required at which the highest Nz is available, for the current aircraft configuration is indicated

Autopilot Symbology

The symbology associated with the autopilot is shown in Figure 1.32 and Figure 1.34 .

The barometric altitude acquire value, set by the pilot, is presented digitally at the top of the display when the autopilot barometric altitude mode has been selected. The initial value of the display is the current barometric altitude of the aircraft with higher or lower values selectable (500ft to 50 000ft, in 100ft increments) via HOTAS moding. For further information refer to Hands on Throttle and Stick pag. 1-107. The altitude acquire display is shown boxed when the autopilot is engaged and the aircraft is climbing or diving to the required altitude. Upon acquisition, the digits of the barometric altitude display are boxed to indicate that the demanded value is being held.

When the autopilot heading or track acquire mode is selected, the demanded value, set by the pilot, is presented digitally at the top of the display preceded by ‘HDG’ or ‘TRK’ as appropriate. The initial value displayed is the current heading or track with new values selectable (from 0 to 359° in 1° steps). The heading or track acquire value is shown boxed when the autopilot is engaged and the aircraft is turning on to the required track/heading. Upon acquisition the value is displayed as three boxed digits. If the heading is being held the digits will be presented within the heading ribbon and centred on the lubber line, however, if a track is being held the digits are presented above the track marker.

When the autothrottle DAS or Mach mode is selected, the demanded value, set by the pilot, is presented digitally at the top of the display, preceded by the letter ‘M’ in the case of Mach mode. The initial value is the current aircraft airspeed or Mach number with new values selectable (‘M0.18’ to ‘M2.00’ in M0.01 increments or ‘110kt’ to ‘726kt’ in 1kt increments) via the HOTAS autothrottle switch. The value is shown boxed at the top of the display when the autothrottle is engaged and the speed is being acquired. Upon acquisition the digits of the displayed airspeed or Mach number are boxed to indicate that the demanded value is being held.

During operation in auto climb mode, ‘A-CLIMB DAS’ or ’A-CLIMB M’ is presented at the top of the display dependent on the mode selected. Whilst in constant airspeed mode ‘A-CLIMB DAS’ is displayed, and similarly when in constant Mach mode ‘A-CLIMB M’ is displayed. The display is mutually exclusive with the Mach/DAS acquire mode described above.

Navigation Symbology

The symbology associated with the navigation is shown in Figure 1.33 and Figure 1.34 .

Initialization Symbology

The LINS alignment cross is a gapped cross that can be slewed within the HUD FOV. It indicates the bearing to a reference object when performing the HUD optical method of LINS alignment. The cross will remain on the HUD until the LINS mode is entered.

The LINS alignment level is a status indication to inform the pilot of LINS alignment error which is expressed in nautical miles per hour.

The TTG to the completion of LINS alignment is presented in digital form. Upon completion of LINS alignment ‘LINS RDY’ is displayed. The system is then ready to enter the navigation mode.

Steering Symbology

The heading ribbon comprises a five dot scale that moves against a fixed lubber line. Each dot represents a 5° increment with heading digits displayed every 10°. Three heading digits are displayed at all times, unless minimum declutter is selected, when only one digit is displayed. When true heading is displayed, the letter 'T' is visible above the center of the scale.

Current track angle is indicated by the track marker, which is read against the heading ribbon. If the marker reaches the limit of the visible ribbon it will park and rotate sideways to indicate that the track error is in excess of the scale.

The steering bug symbol is used to indicate steering required to follow navigation demands. The symbol is read against the heading ribbon and will park and rotate sideways if the steering error is in excess of the visible ribbon.

Waypoint Symbology

An analogue indication of time early/late is presented if the current Destination Way Point (DWP) has been allocated a planned time. A pointer moves against a linear scale comprising three marks: the centre mark represents 0 seconds; the left mark (annotated 'L') represents -60 seconds (late); the right mark (annotated 'E') represents +60 seconds (early). If the time, early or late, exceeds the limits of the scale the pointer parks and rotates sideways to point off the scale.

A digital readout showing the number of current DWP is displayed. A letter is displayed adjacent to the waypoint number to identify waypoint type: eg '199 C', where:

– C represents a combat air patrol point.
– M represents a mark point
– F represents a fuel point
– No letter represents a route point.

Waypoint bearing and range is provided in a digital readout below the DWP number and is expressed in degrees and nautical miles respectively.

TTG until the current DWP is reached is expressed digitally in minutes and seconds below the early/late display.

During close navigation (65 seconds to go) a waypoint countdown circle is presented to provide a 60 second countdown to the DWP. As the aircraft approaches the waypoint the circle winds down, however, if the aircraft starts to move away from the waypoint the circle will wind up again.

Also during close navigation the direction of turn (left or right) and the planned track to the next waypoint are indicated by a triangular pointer and a digital readout respectively. However, if the track of the next waypoint after the current DWP are the same, the symbology will not be displayed.

The route destination waypoint marker is a gapped diagonal cross is used to indicate the expected LOS to the waypoint during the close navigation phase. If the aircraft is above 10 000ft the symbol is not displayed. However, if the route DWP has no height associated with it, then the system assumes that the aircraft is at zero feet AMSL. In addition, if the aircraft is below 10 000ft AMSL and starts to gain height, the symbol will not occult until the aircraft goes higher than 11 000ft AMSL.

Navigation Aids Symbology

The selected TACAN channel number is displayed as a digital readout. Range and bearing from the selected TACAN beacon are displayed digitally in degrees and nautical miles. The selected beacon is identified as an air to surface or an air to air beacon by the letters 'AS' and 'AA' respectively.

Miscellaneous Navigation Symbology

'NO MONITOR' is presented when the LINS/best navigation cross monitor is not available.

'RAD ALT' is presented digitally with up to four digits: 0 to 5000ft in 10ft increments. If RAD ALT only has been selected and the RAD ALT unlocks, or the aircraft exceeds 5000ft, the RAD ALT digits are replaced by flashing barometric altitude figures. If BARO ALT/RAD ALT mode is selected and the RAD ALT data is invalid, unlocked or off, then the digits are replaced by dashes.

Air to Air Attack Symbology

The symbology associated with air to air attack is shown as follows:

– Radar track/target symbology (Figure 1.35)
– Combat steering and air to air missile symbology (Figure 1.36)
– Gun, visual ident and miscellaneous symbology (Figure 1.37)
– An example of a HUD air to air attack format is shown in Figure 1.38
– Examples of radar air combat mode formats are shown in Figure 1.39 , Figure 1.40 and Figure 1.41 .

Radar Track/Target Symbology

A gapped square indicates the sight line to a track of unknown allegiance. The appearance of the symbol is changed if the track moves outside current scan volume to indicate that it is being tracked in memory only. If a Track Cross Reference Index (TCRI), a letter unique to that particular track, has been generated it will be displayed centrally above the track symbol. A pointer is displayed against the track

symbol, which continually indicates horizontal aspect angle of the track. The symbol and aspect angle pointer are displayed in one of three sizes, dependent upon the current range to the track as follows:

– Small size for track range greater than 20nm
– Medium size for track ranges 10 to 20nm
– Large size for track ranges 0 to 10nm.

A gapped circle with four dashes, indicates the sight line to a friendly track. Memorized tracking, aspect angle and the relationship between symbol size and target range are the same as that described for an unknown track above.

A gapped diamond indicates the sight line to a hostile track. Memorized tracking, TCRI, aspect angle and the relationship between symbol size and target range are the same as that described for unknown track position above.

A square symbol indicates the sight line to up to seven secondary targets (targets 2 to 8 in the Designated Target List (DTL)) of unknown allegiance, along with their TCRI; known as an unknown target marker. Memorized tracking, TCRI, aspect angle and the relationship between symbol size and target range are the same as that described for unknown track position above.

A circle indicates the sight line to up to seven friendly secondary targets (targets 2 to 8 in the DTL); known as a friendly target marker. Memorized tracking, aspect angle and the relationship between symbol size and target range are the same as that described for unknown track position above.

A diamond indicates the sight line to up to seven hostile secondary targets (targets 2 to 8 in the DTL), with their TCRI; known as a hostile target marker. Memorized tracking, TCRI, aspect angle and the relationship between symbol size and target range are the same as that described for unknown track position above.

A square with a square border indicates the sight line to a target of unknown allegiance, occupying the first position in the DTL, long with its TCRI; known as an unknown first target marker. Memorized tracking, TCRI, aspect angle and the relationship between symbol size and target range are the same as that described for unknown track position above. In addition, if the target moves outside the HUD FOV the symbol will flash and move around the edge of the display on a line between the target and the centre of the display.

A circle with a circular border indicates the sight line to a friendly target which is the first target in the DTL; known as a friendly first target marker. Memorized tracking, aspect angle, target movement outside the HUD FOV and the relationship between symbol size and target range are the same as that described for unknown first target marker above.

A diamond with a diamond border indicates the sight line to a hostile target which is the first target of the DTL; known as a hostile first target marker. Memorized tracking, TCRI, aspect angle, target movement outside the HUD FOV and the relationship between symbol size and target range are the same as that described for unknown first target marker above.

A gapped diagonal cross is used to indicate that the radar is currently locked to an air to air target; known as radar lock on.

A small diamond is displayed against the first target in the DTL when a valid shoot condition exists; known as the shoot cue.

An analogue indication of the longest time the AMRAAM will take to acquire a target autonomously, if fired presently, is indicated by a marker which moves around the edge of the target symbol. The marker moves anticlockwise to indicate countdown vice versa. Before countdown, when the marker is positioned at the top of the display, a time of 60 seconds or greater is indicated. Below 60 seconds the marker moves around the box, which is scaled such that 30 seconds is at the bottom and zero seconds is top centre.

A cross that fills the inside of the target symbol indicates that the target has been fired at, ie missile in flight. If the time to the target exceeds the missiles flight time, such that it will never reach the target unless the target moves favourably, the symbol will flash. If the missile can never reach the target the symbol is occulted.

A diagonal cross indicates that the minimum MRAAM, SRAAM or gun range has been reached for the associated target; known as a minimum range cross. When MRAAM is selected, the cross may be shown against any of the first six targets in the DTL. When SRAAM is selected the cross will be shown centred on the first target only. When the gun is selected the cross will be centred on the director gun sight. The cross is also shown centred on the aircraft symbol, to indicate minimum radar range plus 10 meters, when in visual identification (VISIDENT) mode.

Combat Steering

A circle and a dot are used to display the Allowable Steering Error (ASE) for an intercept course that will provide a valid firing solution against the current target. The circle varies in diameter to show current ASE and the dot shows actual azimuth and elevation error. To maintain the intercept course the aircraft must be maneuvered such that the steering dot remains within the ASE circle. The steering dot will begin to flash if the error exceeds a certain threshold.

A large diagonal flashing cross centred on the aircraft symbol indicates that a breakaway is

required to avoid collision with the target being attacked.

AMRAAM Symbology

A gapped circle of fixed diameter, having six dashes and centred on the LFD, indicates the area in which the AMRAAM will search when launched in visual mode (7.5° around the bore sight); known as the acquisition cone.

The weapons scale and marker is a vertical linear scale and marker, used to compare target range against the AMRAAM envelope. The system calculates the minimum and two maximum weapon ranges, which are marked on the scale as horizontal lines. The two maximum ranges differ as one range is based on the target remaining at 1g (R MAX 1), while the other assumes that the target will perform an escape maneuver during the AMRAAM fly out (R MAX 2). The shorter of the two ranges is the 'no escape' limit. A target range marker is displayed, which moves from beyond R MAX 1 into the missile range scale as the aircraft closes on the target. As the range to the target decreases below 2nm, sight line range to target is displayed in feet below 12 200ft. Should the target range increase above 14 000ft, the display changes back to nautical miles. In addition, the greater of the two R MAX figures is displayed at the top of the scale (nm). If the target range is less than R MIN the marker will park at the R MIN marker and rotate to point downwards. If the target range is greater than the HUD FOV limit, the marker will park and rotate to point up. The rate of closure is displayed in knots below the range scale and the target aspect angle is displayed directly below that.

A circle of fixed diameter, centred on the aircraft symbol, is used to indicate range to target when the sight line range is less than, or equal to 12 000ft. It is known as the missile target range circle. The circle unwinds as the range decreases. If AMRAAM is selected, AMRAAM minimum range is displayed as a dot on the range circle. Similarly, if SRAAM is selected, SRAAM minimum range is presented in the same way.

Missile time to release is indicated by digital readout; the earliest opportunity to release an AMRAAM inside R MAX 1 against the first target in the DTL.

A digital readout indicates the longest time the missile will take to acquire a target autonomously, if fired presently, against the first target in the DTL. It is known as 'missile time to go autonomous'. The readout appears automatically when the target is within R MAX 1 of the missile envelope.

A digital readout indicates the time to autonomous operation for the AMRAAM currently in flight with the longest flight time.

AMRAAM turn away limits are presented as a box of variable size and position, surrounded by inward pointing arrows. During the post launch phase of an AMRAAM attack, the system calculates the steering limits, in both azimuth and elevation, that the pilot must adhere to in order to keep the target within radar gimbal limits. To adhere to the limits the pilot must maneuver the aircraft so that the velocity vector remains inside the box.

In the event of a multiple AMRAAM attack, with the missiles in flight, the system evaluates the turn away limits for each missile and then calculates their combined turn away limits. The combined limits are calculated such that all targets remain within the radar gimbal limits and that all missiles remain within the data link side lobes.

SRAAM Symbology

A gapped diamond is used to indicate current seeker head look angle, where the seeker has not yet acquired a target. If the seeker head moves outside the HUD FOV, the symbol will flash and move around the edge of the display, along a line between the seeker head position and the centre of the display. The symbol is enlarged if SRAAM wide FOV (XFOV) is selected.

A hexagon is used to indicate the current seeker head look angle, where the seeker has acquired a target. If the seeker head moves outside the HUD FOV, the symbol will flash and move around the edge of the display along a line between the seeker head position and the centre of the display.

The SRAAM target range circle is presented as a circle of fixed diameter, centred on the aircraft symbol, and indicates the range to the target when sight line range is less than, or equal to, 12 000ft; the circle unwinds as the range decreases. If SRAAM is selected, SRAAM minimum range is displayed as a dot on the range circle.

The SRAAM weapons scale and marker are used to compare target range against the SRAAM envelope. Presentation is identical to the MRAAM weapons scale and marker (Para) but the value of R MAX 1 is obviously less.

Selection of SRAAM uncage preset is identified by the presence of a letter 'U' below the SRAAM weapon scale symbology.

Gun Symbology

The director gunsight is displayed in the primary and mixed gun modes provided that the radar is in gun lock mode. The sight comprises an aiming pipper, a range to target circle and an indication of closing speed. The aiming pipper is a dot which is used to indicate future sight line to the target in one bullet's time of flight. The range to target circle is a fixed diameter circle which is centred on the aiming pipper and is used to indicate sight line range to the target from 12 000ft to 0 ft. The circle unwinds anticlockwise as the range to the target decreases.

Two event markers are displayed against the circle representing minimum and maximum gun ranges. A digital readout of closing or opening speed is displayed in knots directly below the gunsight: a closing speed is indicated by (+) and an opening speed by (-). If the target moves outside the HUD FOV the symbol will flash and move around the edge of the display on a line between the target and the centre of the display.

The gun boresight cross is presented as a fixed cross that reflects the angular difference between the gun datum and the LFD.

The historic gun tracer line is displayed in gun secondary mode and represents the flight path of the bullet stream over a 2 second period against three range bars. The tracer line is 2 seconds in length and comprises a line of sixteen segments, each segment representing 0.125 sec. Range bars corresponding to 1000ft, 2000ft and 3000ft are shown with the tracer line and represent fixed target wing spans of 50ft, 40ft and 30ft. Every 2 seconds the path of gun rounds, down the tracer line, is shown by a gap of two segments known as the ‘dark bullet’. The gap travels down the tracer line at bullet speed to provide an indication of timing.

The gun scale and marker are used to compare target range against the gun envelope. Presentation is similar to that for the air to air missiles, however there is only one R MAX value.

Visual Identification Symbology

The steering position cue enables the pilot, in VISIDENT mode, to nominate a steering position on either a 30° or a 50° cone from behind the target, which will drive the steering dot, ie, Single Target Track (STT) and target, less than max VISIDENT range. Each cone has twelve selectable positions represented by a circular pattern of twelve dots. The VISIDENT target altitude, track and airspeed are also displayed in digital format within the circular pattern.

When selected the X-Y marker (a gapped cross) appears on the default position (6 o’clock position on the 30° cone) or the previously selected position, along with a circular marker. The pilot can then move the X-Y marker to any of the other positions and perform an X-Y insert to confirm the selection. A visual confirmation of the selection is provided by the circular marker which repositions itself on the newly selected position.

Target parameters, ie, track, altitude and airspeed, are indicated in digital form within the VISIDENT steering position cue symbology.

The target range circle is presented as a circle of fixed diameter, centered on the aircraft symbol, and indicates the range to the target when sight line range is less than 2nm. The circle unwinds as the range decreases, eventually occulting at 180m. An event marker is positioned on the circle to indicate the minimum VISIDENT range. An indication of closing (+) or opening (-) speed, in knots, is displayed directly beneath the range circle.

Closing or opening speed is indicated in both analogue and digital forms. The analogue display comprises a pointer which moves against a fixed speed scale covering the range +80kt to -20kt. The speed scale is presented as six evenly spaced dots, where the space between each dot represents 20kt. An elastic line connects the pointer and the dot that represents 0kt, to enable the display to be read quickly and easily. If the closing speed is beyond the limits of the display the pointer parks at the maximum value and rotates sideways. A digital readout of closing speed (in knots) is also provided adjacent to the analogue display, which is able to indicate closing (+) or opening (-) speeds beyond the limits of the analogue display.

Range to target is indicated in analogue and digital forms by the range scale. The analogue display comprises a pointer which moves against a fixed vertical scale, on which maximum and minimum VISIDENT ranges, and minimum radar lock range are marked. As the aircraft is maneuvered towards the target, the marker moves down from the top of the HUD FOV towards the range scale. Actual sight line range to the target in nautical miles is indicated by a digital read out adjacent to the pointer. As the range to the target decreases below 1nm, sight line range to target is displayed in feet below 6080ft. Should the target sight line range increase above 7000ft, the display changes back to nautical miles.

Miscellaneous

An indication of weapon selection is provided by the air to air weapons display at the bottom right corner of the HUD. If no weapons are currently selected the letters ‘M’, ‘S’ and ‘G’ are displayed representing MRAAM, SRAAM and gun respectively. Each letter is suffixed by a number denoting the quantity of stores/rounds remaining or the letter ‘X’ denoting no stores/rounds remaining. When an air to air weapon is selected its associated letter is replaced by boxed text ie, ‘MRAAM’, ‘SRAAM’ or ‘GUN’ as appropriate. If SRAAM reject has occurred the number of rejected SRAAM is displayed in brackets adjacent to the SRAAM remaining display. SRAAM slaved and manual modes are also displayed as a ‘S’ or ‘M’ suffix respectively.

The text ‘SHOOT’ is presented boxed, when a valid firing opportunity exists against the next target; known as the shoot cue.

Target aspect angle is the angular difference between a target’s track and own aircraft centre line: the angle is expressed from 0 to 180° left or right. If the difference is less than 10° left or right (expressed as ‘1L’ or ‘1R’) a letter ‘T’ is displayed denoting ‘tail

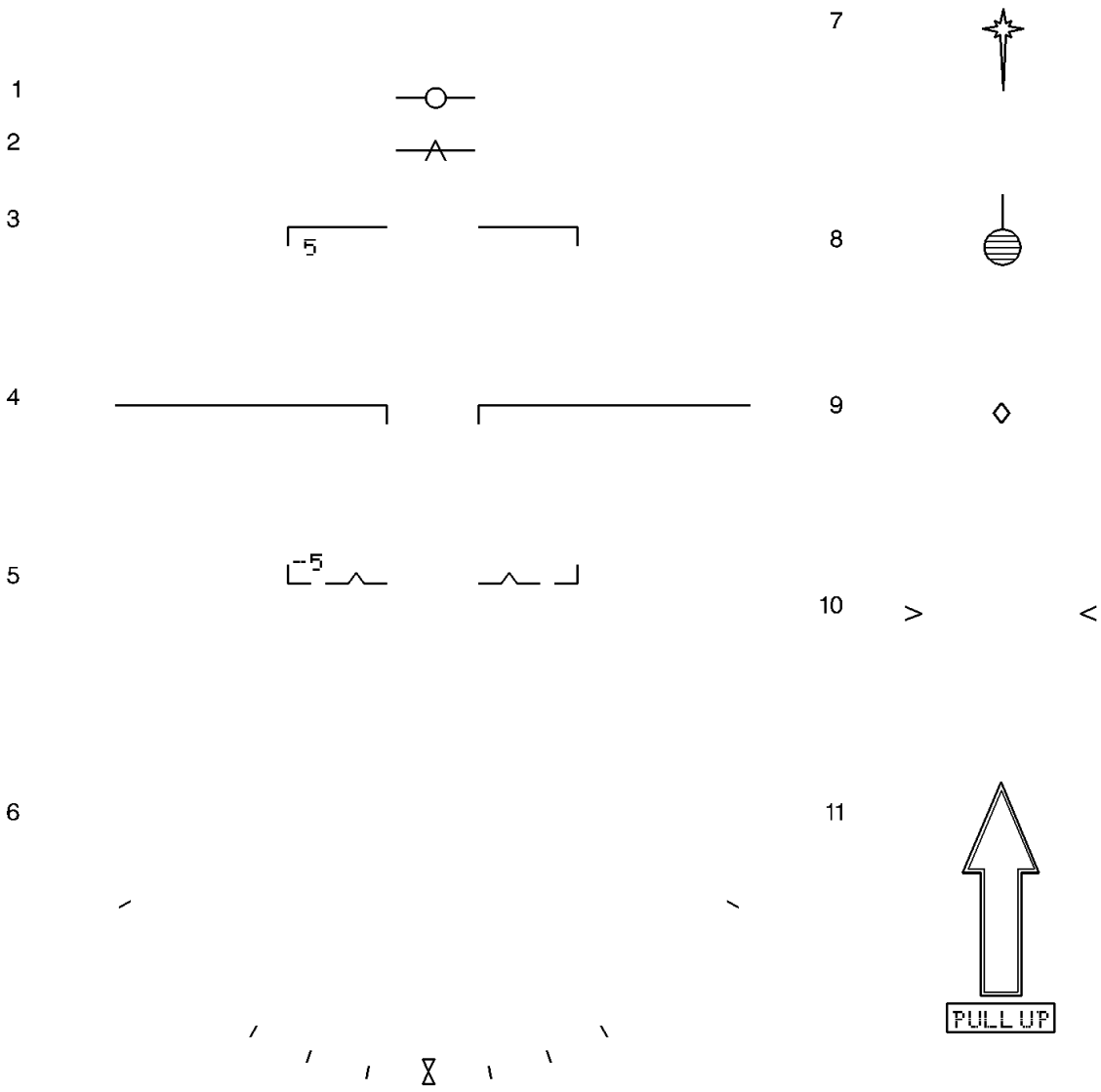
chase'. If the difference is greater than 170° left or right (expressed '17L' or '17R') the letter 'H' is displayed denoting 'head on'.

Radar Air Combat Mode Symbology

The area of scan volume during HUD acquisition (HUDQ) mode is indicated by outlining the HUD FOV. The radar locks to the first detected plot in the scan volume.

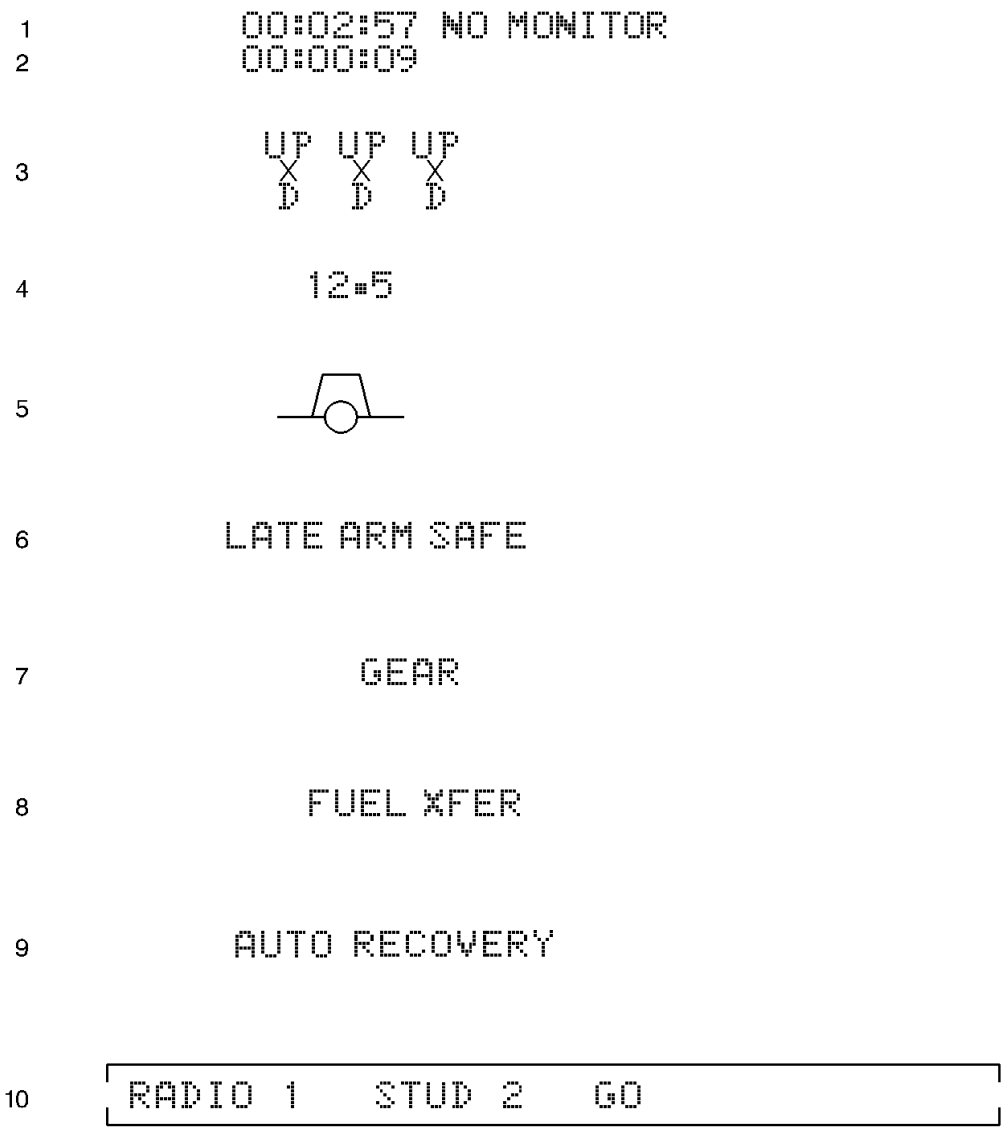
The area of scan volume during vertical acquisition (VACQ) mode is displayed by outlining the vertical pattern on the HUD. The radar locks onto the first plot detected within the two bar vertical pattern.

The area of scan volume during radar slaved acquisition (SACQ) mode is indicated by a circle of fixed diameter. Upon selection of the mode the initial sight line is boresight, however, the sight line can be slewed anywhere within the HUD FOV using the X-Y controller. The radar will lock to the nearest plot in this mode.



1 CLIMB/DIVE SYMBOL
2 ATTITUDE SYMBOL
3 CLIMB BAR
4 HORIZON BAR
5 DIVE BAR
6 BANK/ROLL POINTER
7 ZENITH STAR
8 NADIR
9 VELOCITY VECTOR
10 SPECIFIC EXCESS POWER MARKER
11 PULL UP ARROW

Figure 1.27 - Attitude/Directional Reference Symbology



1 STOPWATCH COUNT UP
2 STOPWATCH COUNTDOWN
3 UNDERCARRIAGE STATE
4 DEPRESSION ANGLE
5 AIRBRAKE INDICATOR
6 LATE ARM SAFE INDICATION
7 GEAR LIMIT INDICATION
8 FUEL TRANSFER STATUS
9 AUTO RECOVERY
10 DIRECT VOICE INPUT

Figure 1.28 - Miscellaneous Symbology

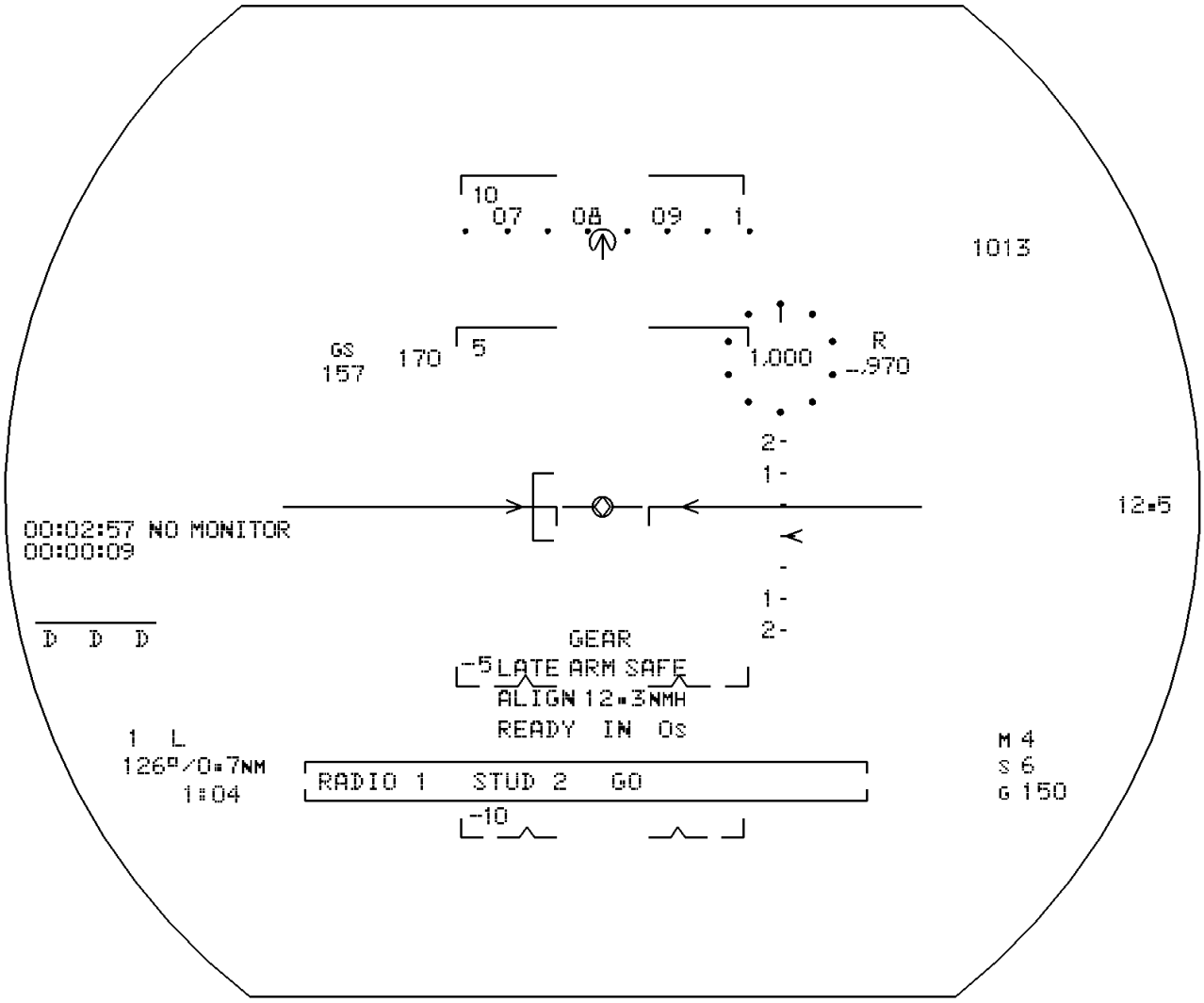
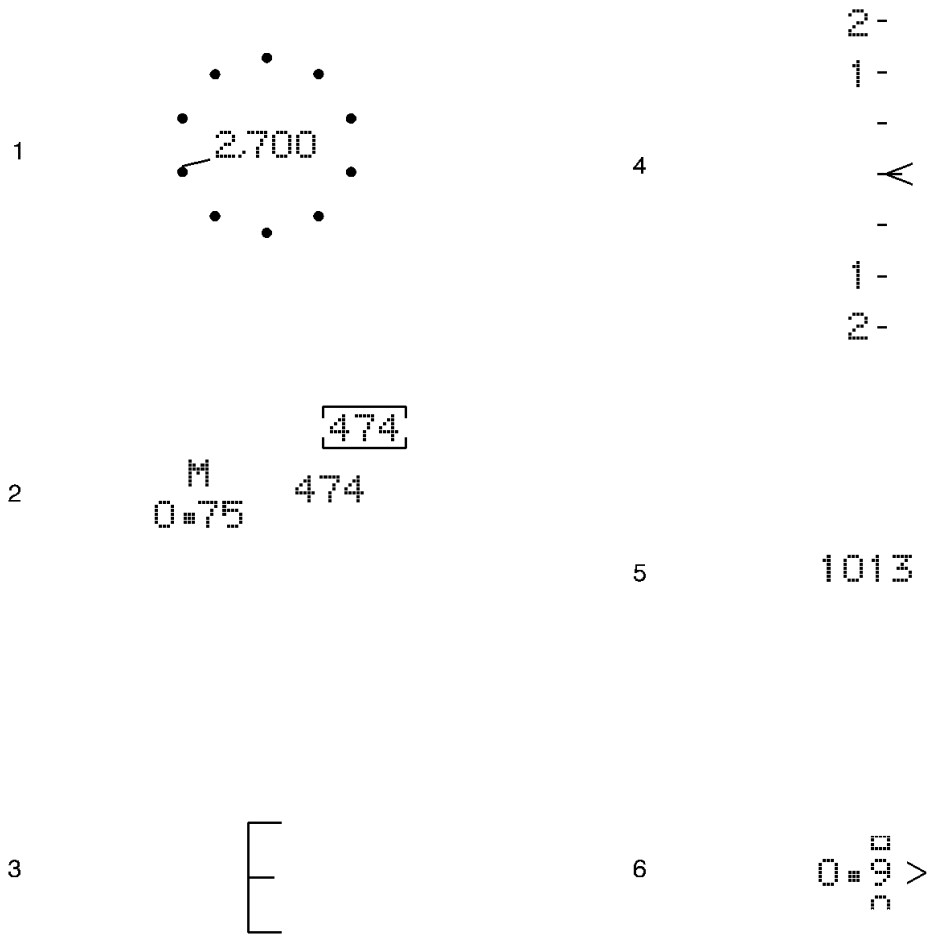
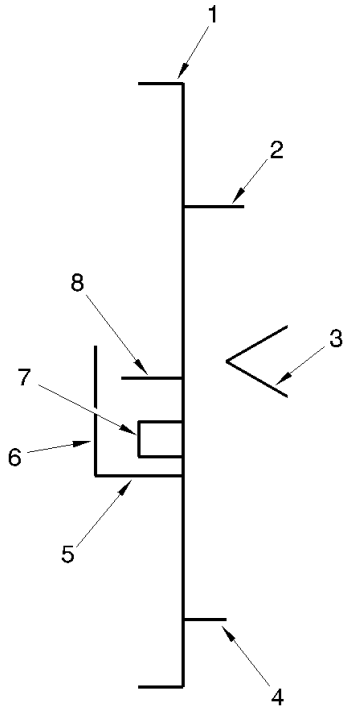


Figure 1.29 - Example HUD Format (Attitude, Directional and Miscellaneous Symbology)



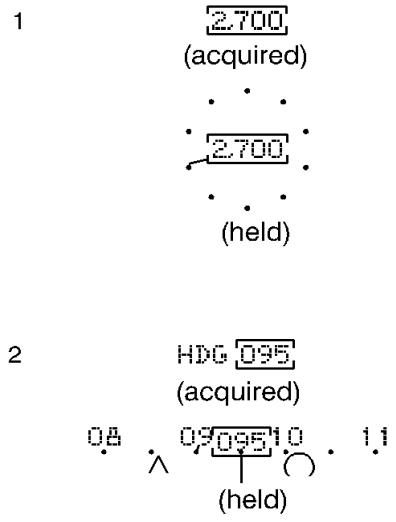
1 BAROMETRIC ALTITUDE DISPLAY
2 DISPLAYED AIRSPEED/MACH NUMBER
3 ANGLE OF ATTACK SCALE
4 VERTICAL VELOCITY
5 BAROMETRIC PRESSURE SETTING
6 NORMAL G

Figure 1.30 - Airdata Symbology



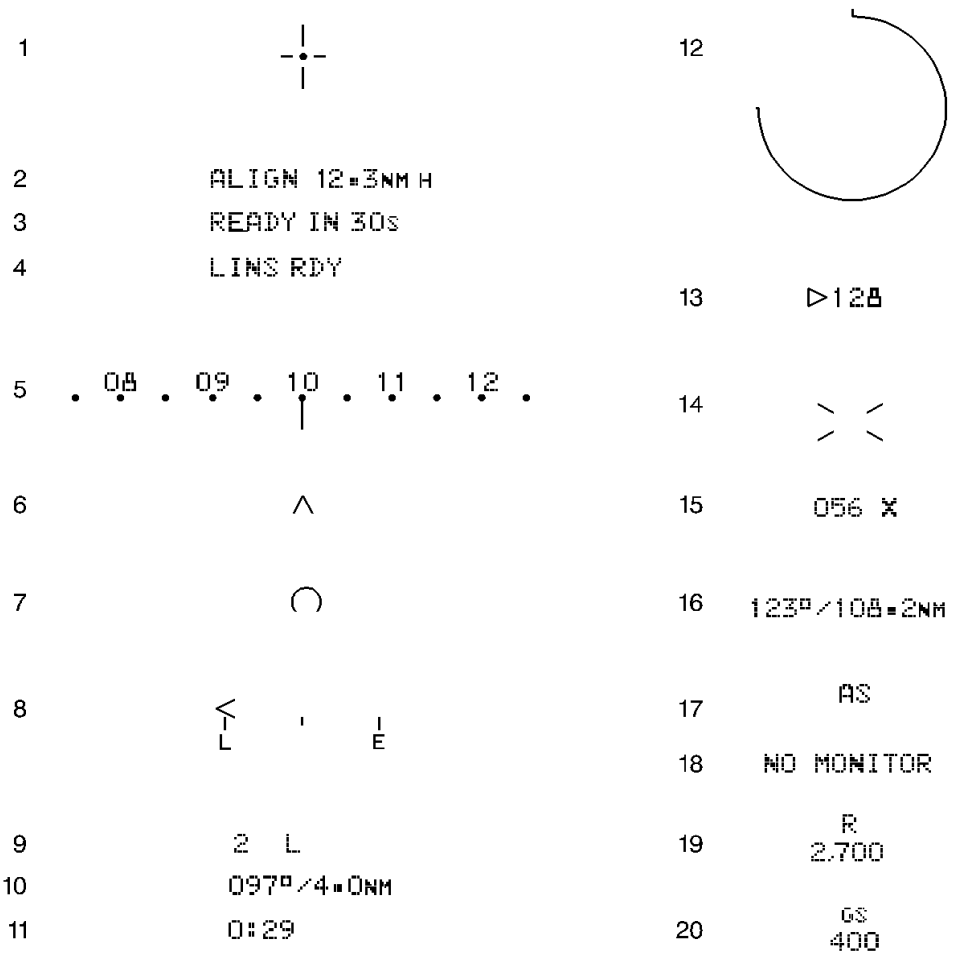
1 SPEED SCALE
2 AOA FOR MAXIMUM STR AT CURRENT SPEED
3 CURRENT AOA
4 ACCELLERATION AOA
5 CURRENT SPEED
6 SPEED TREND
7 SPEED FOR MAXIMUM STR
8 LOWEST SPEED FOR HIGHEST NZ (CORNER SPEED)

Figure 1.31 - Energy Cue Symbology



1 ALTITUDE ACQUIRE
2 HEADING/TRACK ACQUIRE
3 MACH/DAS ACQUIRE
4 AUTO CLIMB

Figure 1.32 - Autopilot Symbology



1	LINS ALIGNMENT CROSS	11	TIME TO GO
2	LINS ALIGNMENT LEVEL	12	WAYPOINT COUNTDOWN CIRCLE
3	LINS ALIGNMENT TIME TO GO	13	DIRECTION OF TURN TO NEXT WAYPOINT
4	LINS ALIGNMENT READY CAPTION	14	ROUTE DESTINATION WAYPOINT MARKER
5	HEADING RIBBON	15	TACAN CHANNEL
6	TRACK MARKER	16	TACAN BEARING AND RANGE
7	STEERING BUG	17	TACAN AIR TO SURFACE/AIR TO AIR
8	TIME EARLY LATE	18	NO MONITOR
9	WAYPOINT NUMBER AND TYPE	19	RADAR ALTITUDE
10	WAYPOINT BEARING AND RANGE	20	GROUND SPEED

Figure 1.33 - Navigation Symbology

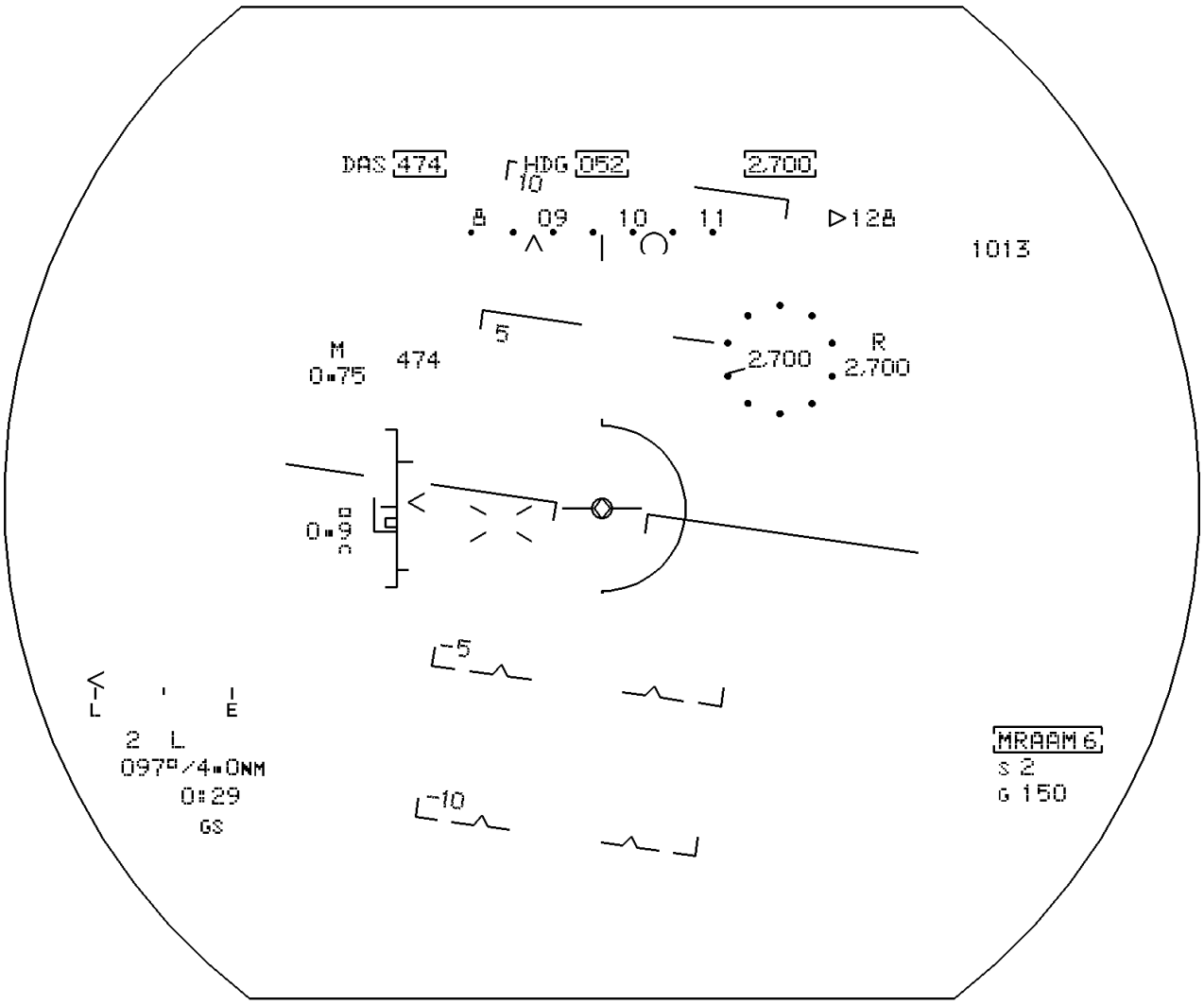
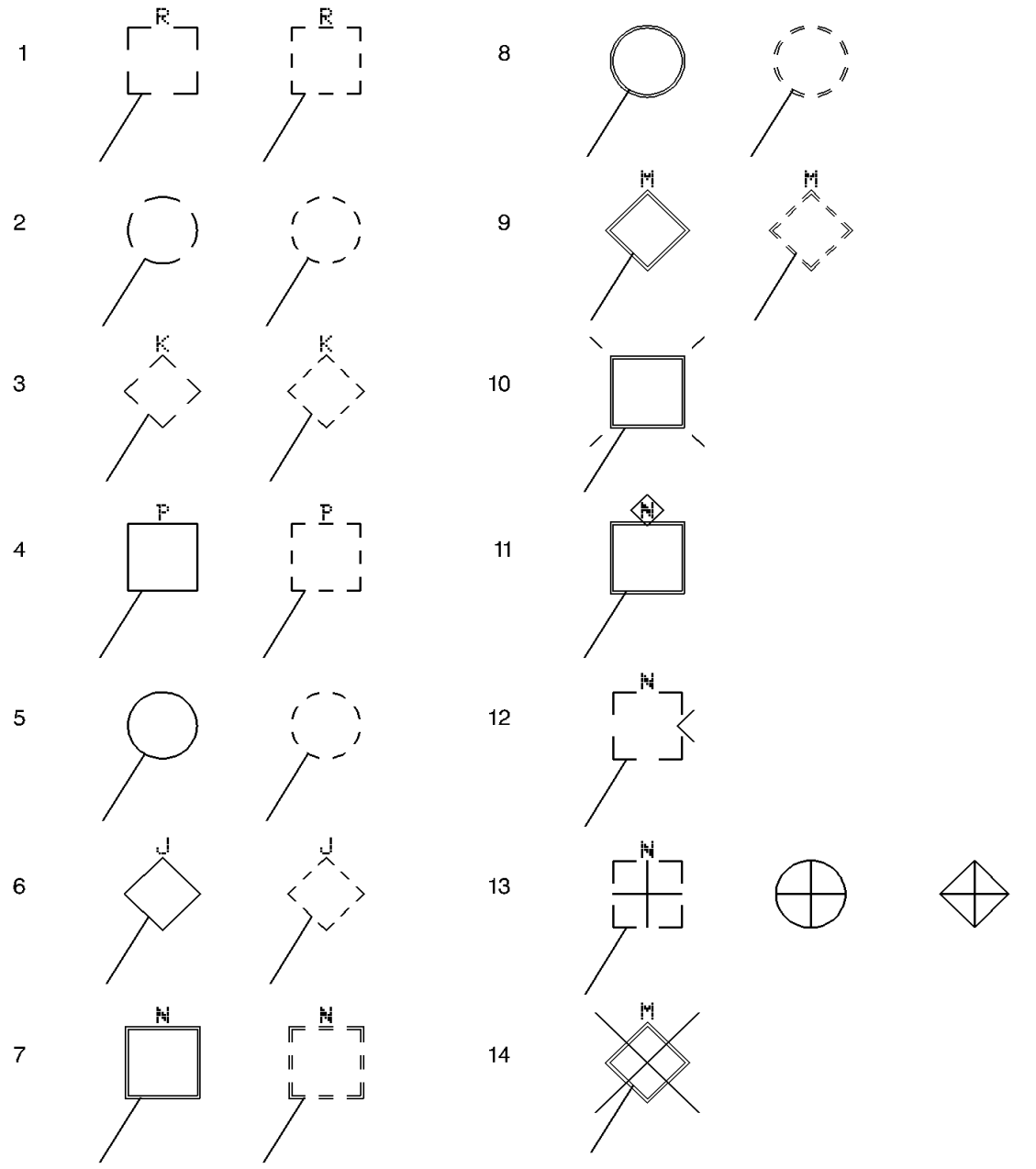
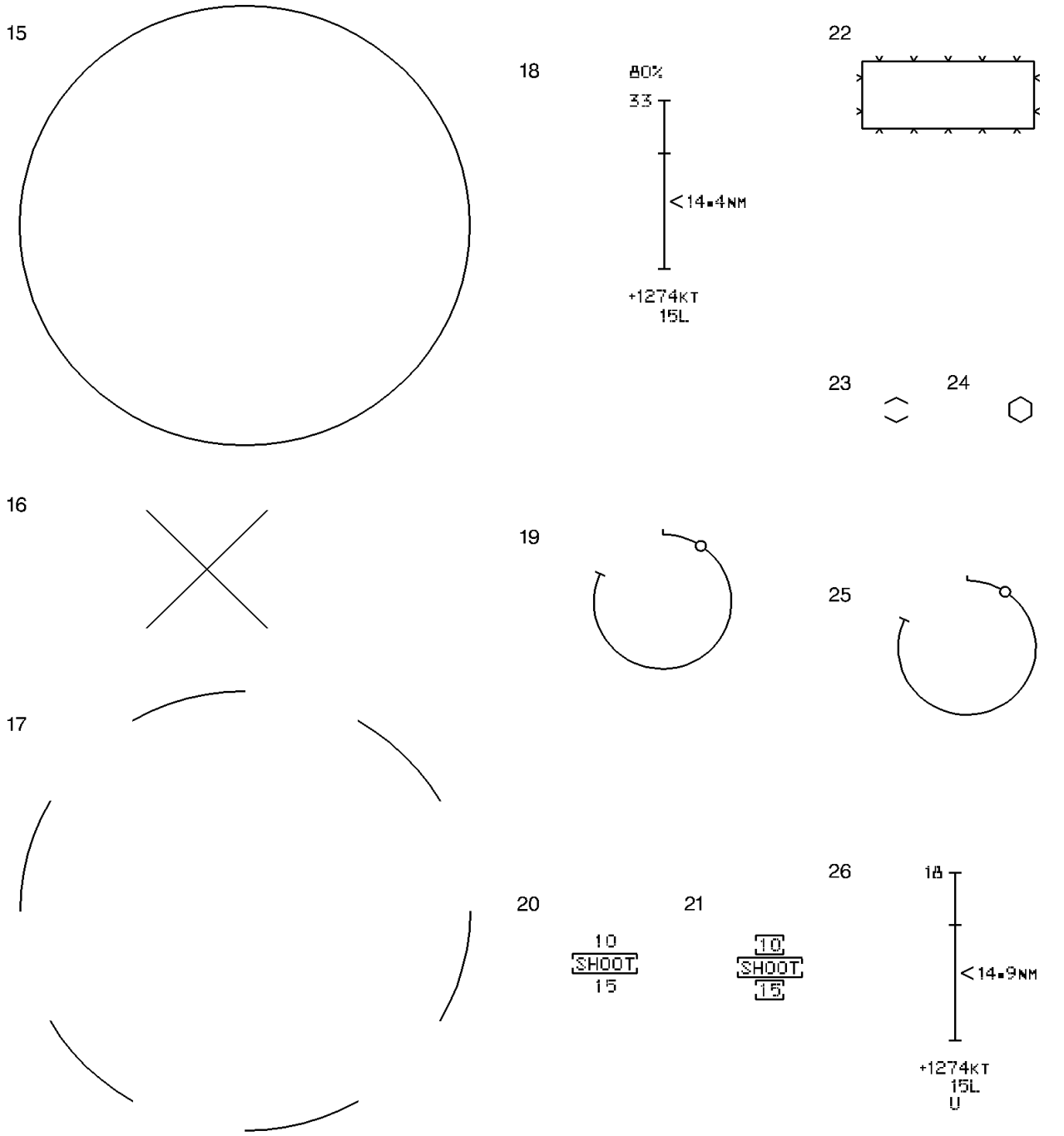


Figure 1.34 - Example HUD Format (Airdata, Autopilot and Navigation Symbology)



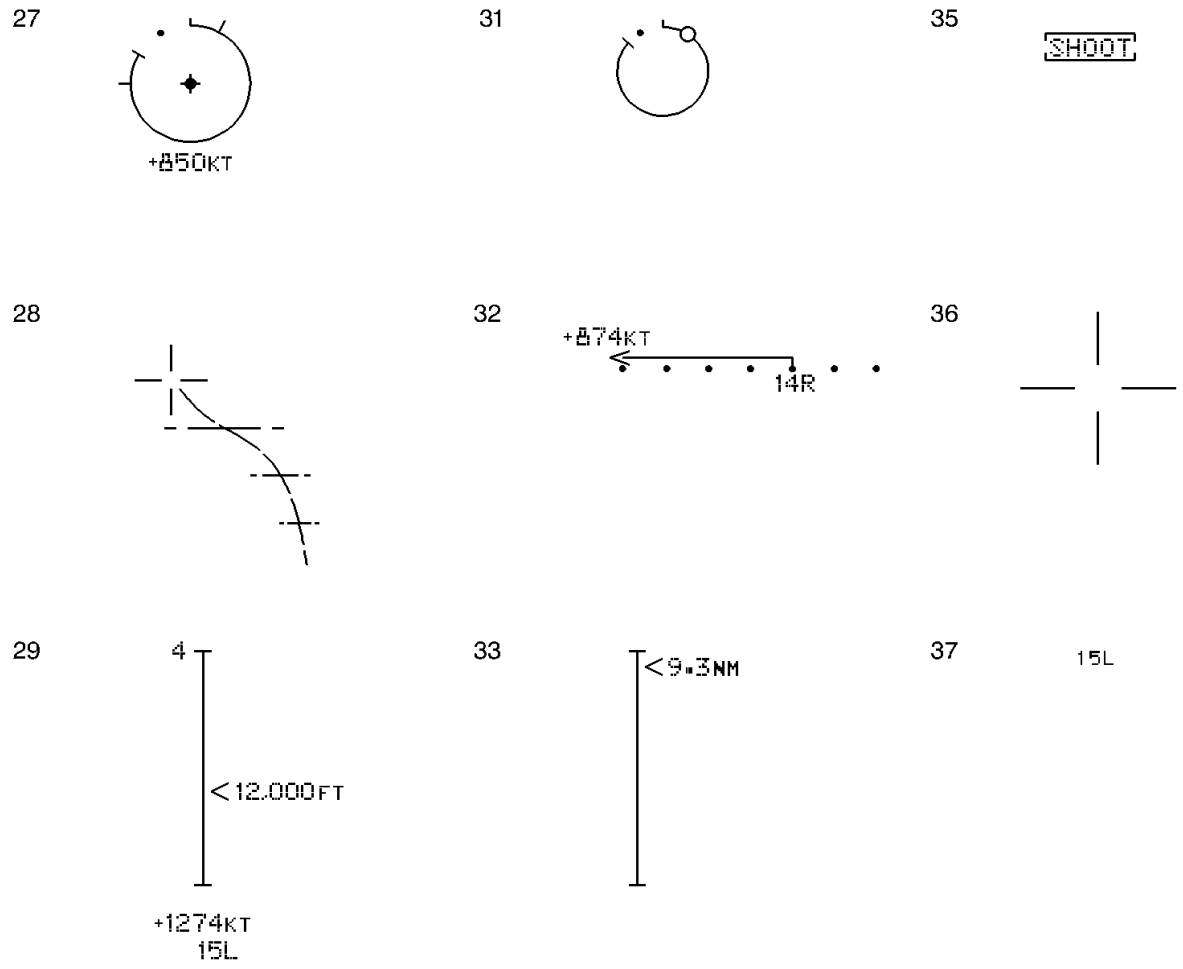
1 UNKNOWN TRACK POSITION
2 FRIENDLY TRACK POSITION
3 HOSTILE TRACK POSITION
4 UNKNOWN TARGET MARKER
5 FRIENDLY TARGET MARKER
6 HOSTILE TARGET MARKER
7 UNKNOWN FIRST TARGET MARKER
8 FRIENDLY FIRST TARGET MARKER
9 HOSTILE FIRST TARGET MARKER
10 RADAR LOCK ON
11 SHOOT CUE
12 AMRAAM LONGEST TIME TO AUTONOMOUS
13 MISSILE IN FLIGHT
14 MINIMUM RANGE CROSS

Figure 1.35 - Radar Track/Target Symbology



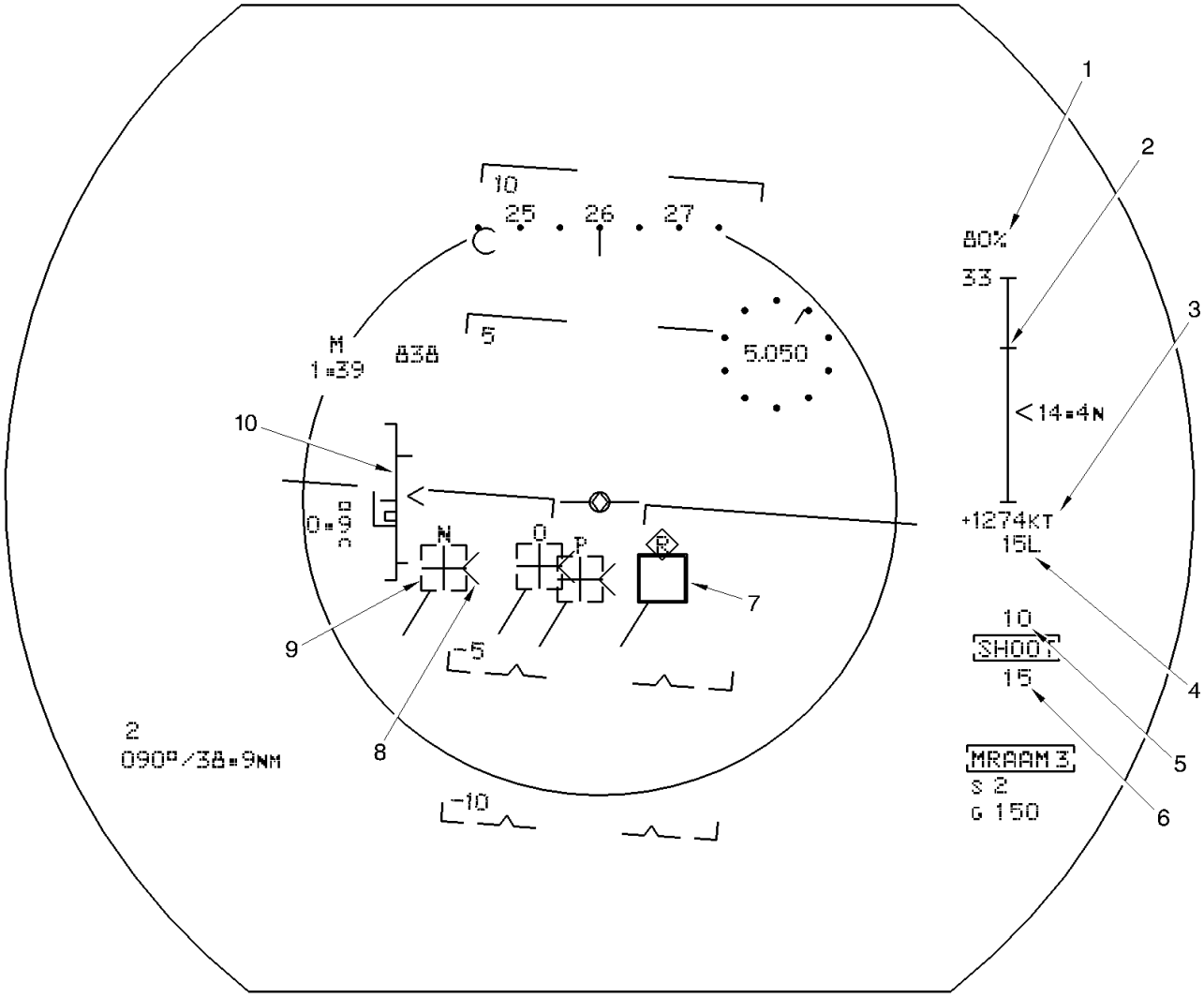
15 ALLOWABLE STEERING ERROR AND STEERING DOT
16 BREAK AWAY CROSS
17 ACQUISITION CONE
18 WEAPONS SCALE AND MARKER
19 MISSILE TARGET RANGE CIRCLE
20 MISSILE TIME TO RELEASE
21 MISSILE TIME TO GO AUTONOMOUS
21 MISSILE IN FLIGHT TIME TO AUTONOMOUS
22 TURN AWAY LIMITS
23 HEAD LOOK ANGLE-NOT ACQUIRED
24 HEAD LOOK ANGLE-ACQUIRED
25 SRAAM TARGET RANGE CIRCLE
26 SRAAM WEAPONS SCALE AND MARKER
26 SRAAM UNCAGE PRESET

Figure 1.36 - Combat Steering and Air to Air Missile Symbology



27	DIRECTOR GUNSIGHT	32	CLOSING SPEED
28	GUN BORESIGHT CROSS	33	RANGE SCALE
28	HISTORIC GUN TRACER LINE	34	AIR TO AIR WEAPONS DISPLAY
29	GUN SCALE AND MARKER	35	SHOOT CUE
30	STEERING POSITION CUE	36	X-Y MARKER
30	TARGET PARAMETERS	37	TARGET ASPECT ANGLE
31	TARGET RANGE CIRCLE		

Figure 1.37 - Gun and VISIDENT Symbology



1 AMRAAM PROBABILITY OF INTERCEPT
2 AMRAAM SCALE AND MARKER
3 RANGE RATE
4 ASPECT ANGLE
5 TIME TO AUTONOMOUS - IF FIRED NOW
6 LONGEST TIME TO AUTONOMOUS - MISSILES IN FLIGHT
7 No.1 TARGET TD BOX
8 TD LONGEST TIME TO AUTONOMOUS
9 TD BOX, MISSILE IN FLIGHT
10 ENERGY CUE

Figure 1.38 - Example HUD Format (Air to Air Attack Mode)

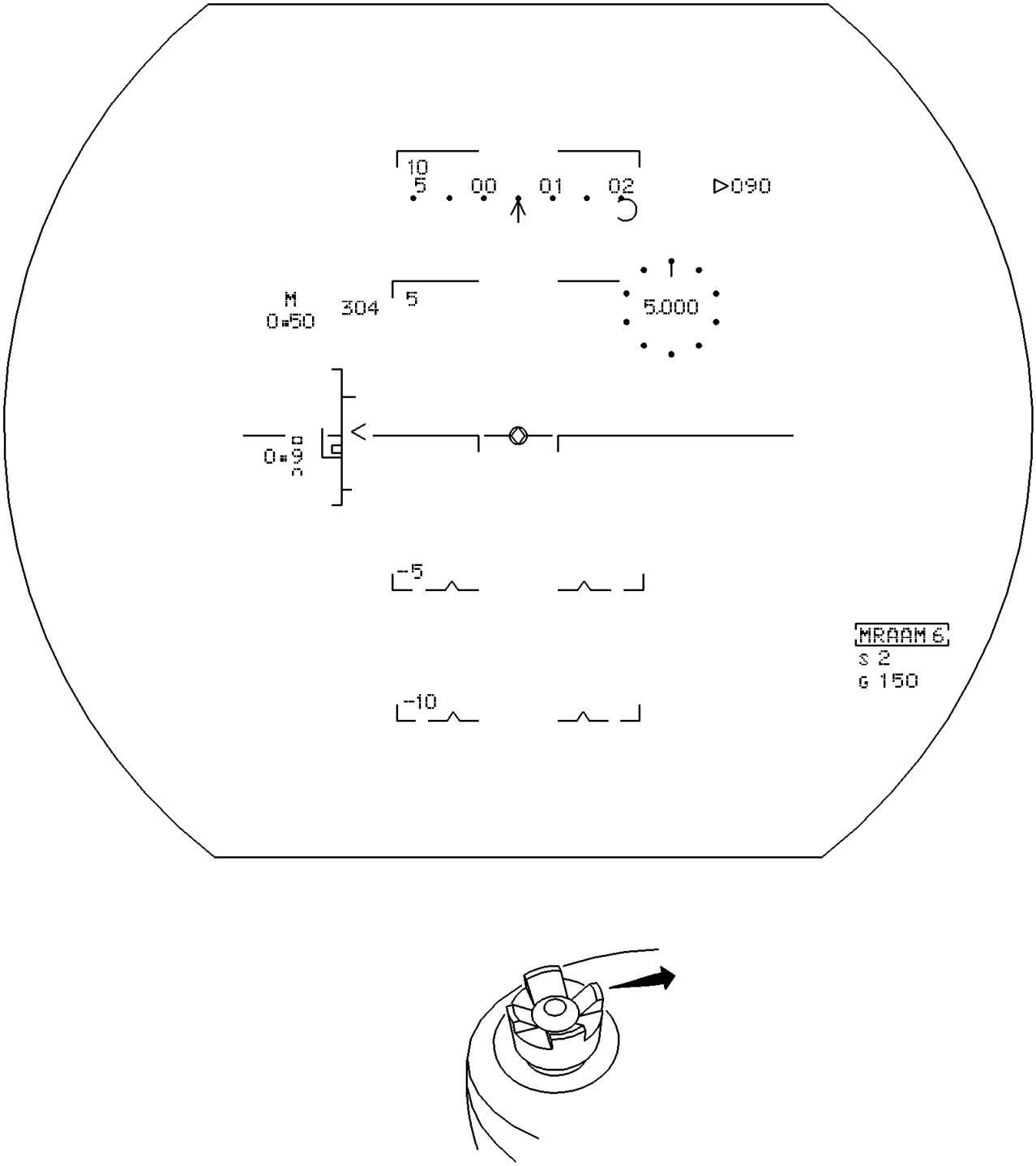


Figure 1.39 - HUD Acquisition

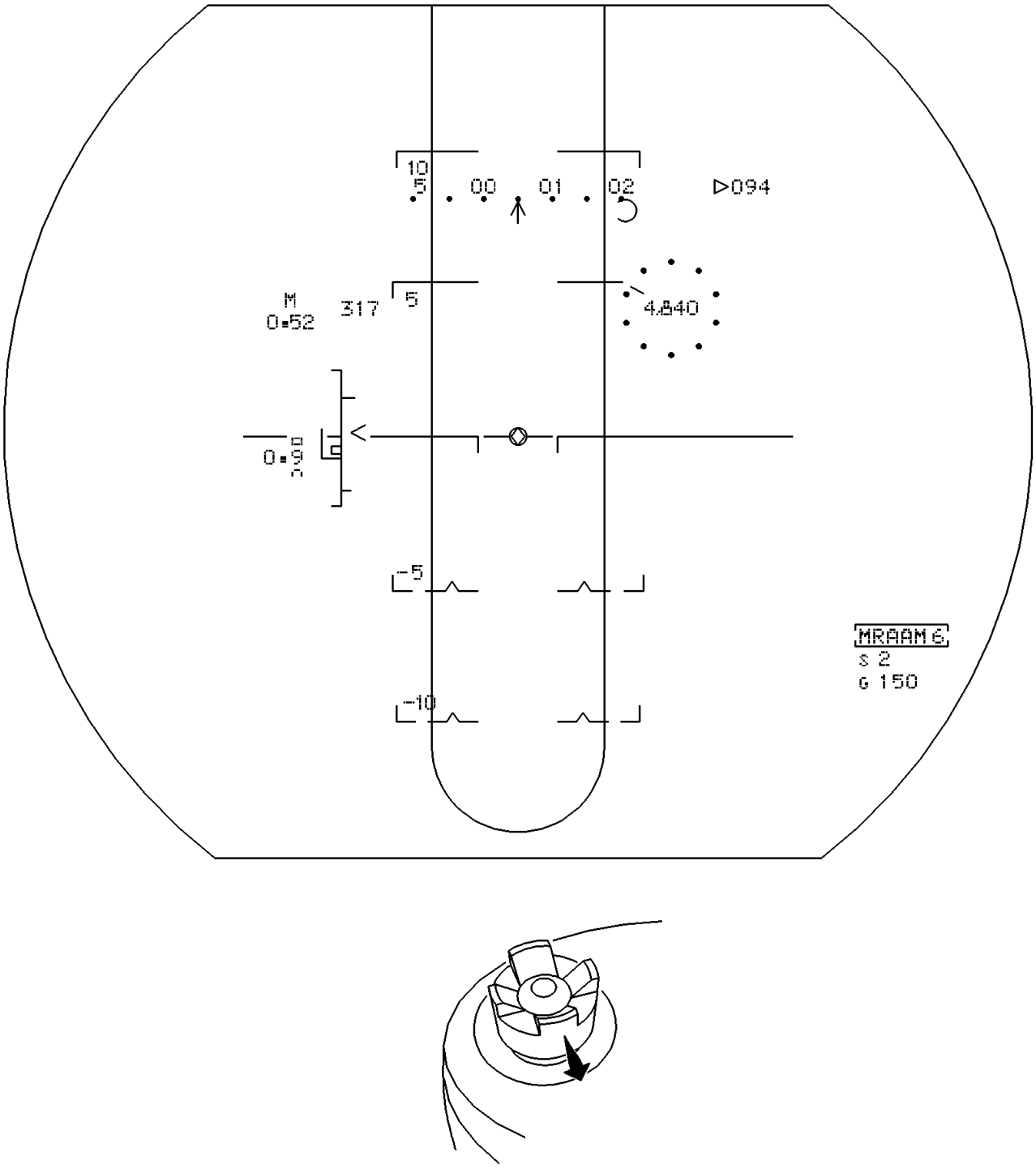


Figure 1.40 - Vertical Acquisition

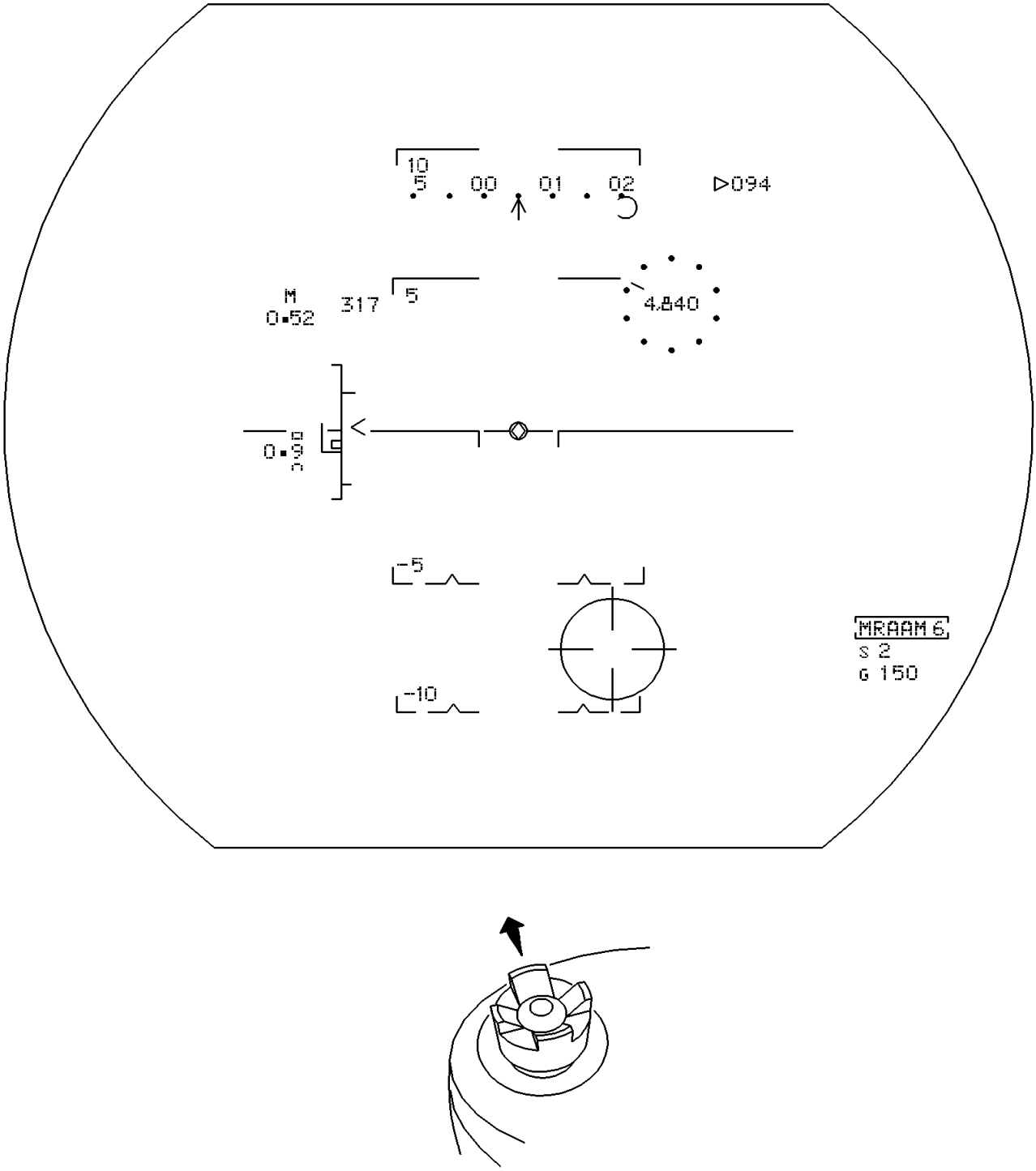


Figure 1.41 - Radar Slaved Acquisition

Head up Display

(1B-B-31-14-00-00A-111A-A Issue 003)

Introduction

The Head up Panel (HUP), Figure 1.42 is located immediately below the PDU and contains the controls and indicators associated with the HUD.

- Lock/VV push button
- GS/M display push button
- Declutter level selector
- BARO/RAD push button
- FLIR display selector
- PDU raster gamma control
- Power switch
- PDU depression setting control
- PDU raster/cursive balance control
- PDU brightness control.

Lock/VV Push Button

A split caption push button, marked LOCK/VV, controls the modes of operation of the aircraft symbol. When set to LOCK, the symbol is locked to the vertical axis of the HUD (indicated by the addition of a radial flag at the 12 o'clock position on the circle) but can be adjusted using the depression setting control. When the push button is set to VV, the symbol is referenced to the aircraft velocity vector in elevation +5° to -15°, with respect to the LFD. The locked tail is added when a limit is reached. On selection of either mode, the relevant caption is highlighted.

NOTE

The VV symbol does not move in azimuth.

GS/M Display Push Button

A split caption push button, marked GS/M, causes the aircraft groundspeed (GS) or Mach number (M) to be displayed in the top left corner of the HUD. The displayed mode can be changed as follows:

- With GS selected, pressing the push button causes the aircraft"s Mach number to be displayed.
- With M selected, pressing the push button causes the aircraft"s groundspeed to be displayed.

When selected, the applicable caption is highlighted. If the aircraft Mach number exceeds M 0.9, the system automatically displays the Mach number. Selections on the HDHUD format will affect the display on the HUD and vice versa.

DCLT Level Selector

A push button, marked DCLT, controls the operation of the three declutter levels (0, 1 and 2). Declutter is necessary to allow the pilot to see the outside world more clearly through the HUD symbology during certain POF. With each operation of the push button, the next declutter level is selected.

With level 2 selected during the ground, takeoff, navigation and combat POF, the 5°, 15° and 25° pitch bars are occulted on the HUD. All other pitch lines and associated symbology are unaffected. However, in the landing POF all pitch bars are displayed.

The barometric pressure setting in level 2 is permanently displayed during the ground, takeoff and landing POF. In the combat and navigation phases, it is only displayed whilst it is being changed; after 5 seconds it will occult.

Weapons indications in level 2 are restricted to the selected weapon and the respective stores that remain. In all other declutter selections, all weapons and their remaining stores are displayed.

The width of the heading scale depends on the declutter level selected. Three widths are available, a wide ribbon showing 55°, a normal ribbon showing 35° and a narrow ribbon showing 15° (Table 1).

The bank angle and/or the VSI will be automatically displayed depending on the POF and the declutter level selected (Table 2).

BARO/RAD push button

A split caption push button, marked BARO/RAD, causes the barometric (BARO) or radar (RAD) altitude to be displayed to the right, above centre, on the HUD format. Depending on the POF the displayed data can be BARO only, RAD only, or both BARO and RAD. However, the RAD only mode is not available with autopilot BARO altitude acquire/hold selected. In addition, if the BARO only mode is selected, and the aircraft descends below 5000ft, the BARO/RAD mode will automatically be selected when RAD data is valid.

During ground operation neither the BARO or RAD altitude data will be displayed on the HUD format and selection will have no effect.

With the aircraft weight on wheels during the takeoff POF, the BARO altitude is automatically displayed on the HUD format; operating the selector will have no effect. With aircraft weight off wheels, RAD altitude is available for selection.

The default mode for the navigation and air to air POF is BARO altitude, however, both are available for selection.

During the landing POF, both BARO and RAD selections are available. With aircraft weight on wheels the system defaults to the BARO status bar illumination and altitude display.

When selected, the applicable caption is highlighted. If the altitude exceeds 5000ft with RAD selected, or the RAD altitude data is invalid, the display defaults to BARO digital altitude and the BARO digits flash. However, the selection status and indication remains at RAD, and when the RAD data becomes valid or the aircraft descends below 5000ft, the display changes back to RAD altitude.

FLIR Display Selector

A push button selector, marked FLIR, causes information derived from the FLIR system to be displayed in addition to the HUD symbology.

PDU Raster Gamma Control

A thumbwheel, labelled CON, controls the Gamma variation to enhance pilot visibility on the PDU of electro optic sensor information. Increase in display Gamma enhances the relative contrast, by increasing the grey shades of the raster display, over the higher range of the input signal levels. As a consequence, the lower range of input signal levels will be suppressed.

Power Switch

A two-position toggle switch, labelled ON/OFF, controls the power supply to the HUP, the PDU and the HUD video camera.

PDU Depression Setting Control

A thumbwheel, labelled DEP, is used to change the depression angle of the aircraft symbol in lock mode. The angle is referenced to the LFD and operates within the range zero to 305 milliradians and is displayed on the HUD. The display will occult 10 seconds after the last input.

PDU Raster/Cursive Balance Control

A thumbwheel, labelled BAL, controls the cursive luminance level relative to the raster Peak White luminance level of the PDU.

PDU Brightness Control

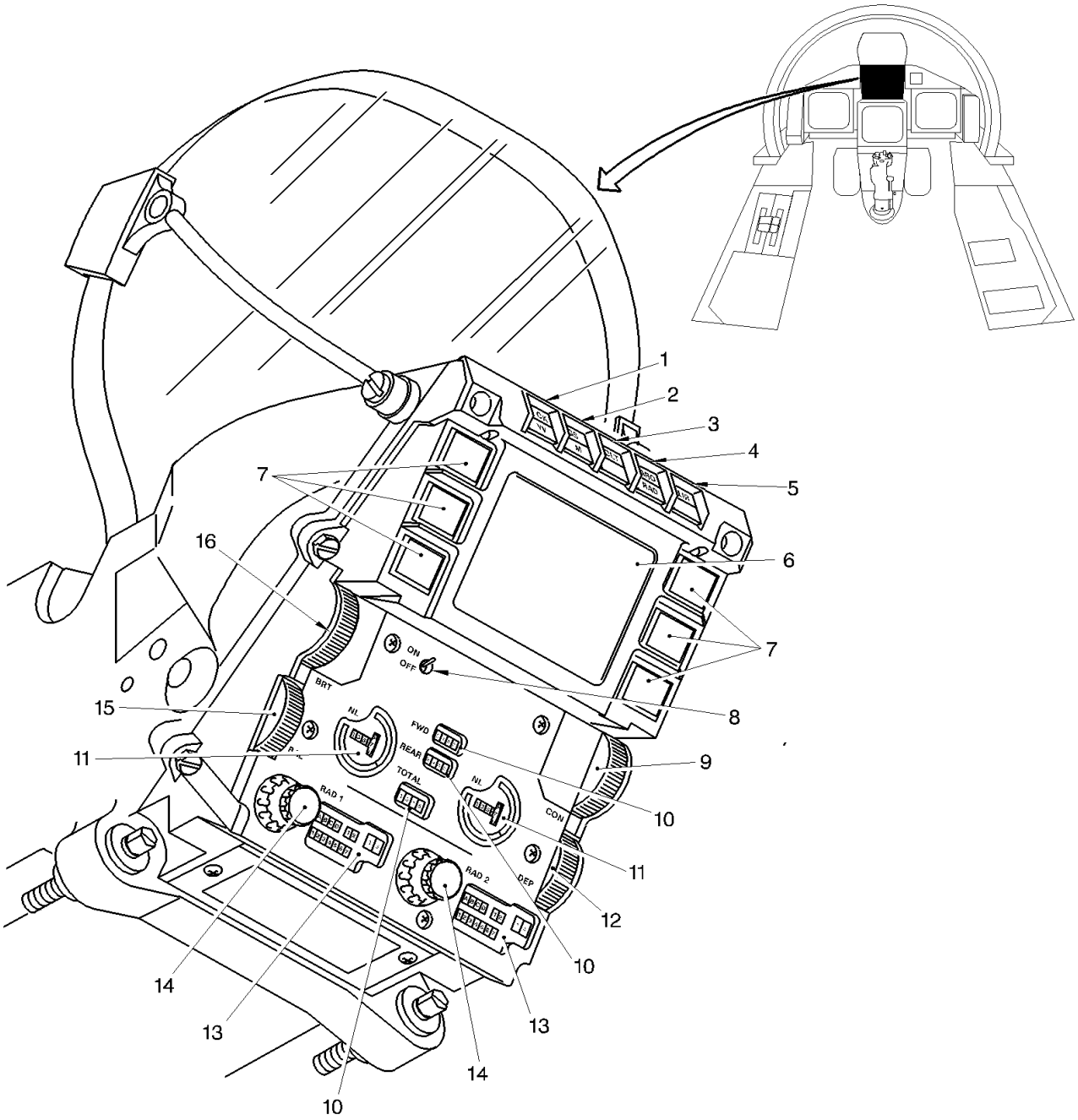
A thumbwheel, labelled BRT, adjusts the brightness level of the HUD. This control references the brightness level of the symbology against which the HUD autobrightness system operates.

Displayed Heading Width with Declutter Selection

Declutter Level	Phase of Flight				
	GND	T/O	NAV	A/A & A/S	LND
Level 0	Wide	Wide	Wide	Wide	Wide
Level 1	Normal	Normal	Normal	Normal	Normal
Level 2	Narrow	Narrow	Narrow	Narrow	Narrow

Bank Angle and VSI Display with Declutter Selection

Declutter Level	Phase of Flight				
	GND	T/O	NAV	A/A & A/S	LND
Level 0	VSI	B & VSI	B & VSI	-	B & VSI
Level 1	VSI	VSI	-	-	VSI
Level 2	-	-	-	-	-



1 LOCK/VV SELECTOR/INDICATOR
2 GS/M DISPLAY SELECTOR/INDICATOR
3 DECLUTTER SELECTOR/INDICATOR
4 BARO/RAD ALTITUDE SELECTOR/INDICATOR
5 FLIR SELECTOR/INDICATOR
6 MIDS DISPLAY (NOT USED)
7 MIDS PUSHBUTTONS (NOT USED)
8 POWER CONTROL SWITCH
9 PDU RASTER GAMMA THUMBWHEEL
10 FUEL READOUT DISPLAYS
11 ENGINE DISPLAY
12 PDU DEPRESSION SETTING THUMBWHEEL
13 COMMUNICATION READOUT DISPLAYS
14 COMMUNICATION CONTROLS
15 PDU RASTER/CURSIVE BALANCE THUMBWHEEL
16 PDU BRIGHTNESS THUMBWHEEL

Figure 1.42 - Head-up Display Controls and Indicators

Multifunction Head down Display

(1B-B-31-15-00-00A-043A-A Issue 004)

Introduction

The cockpit display suite has three Multifunction Head down Displays (MHDD). Each MHDD comprises a 6 inch square flat panel Active Matrix Liquid Crystal Display (AMLCD) with 17 soft-keys located on its surrounding bezel. The MHDD can present a variety of tactical and aircraft system information. Formats are grouped to specific MHDD: the detailed groups are described in this section, but the general principles are that the left MHDD carries tactical attack formats, the center carries the Pilot Awareness (PA) format, while the right carries further tactical displays as well as the bulk of the aircraft system formats. This does not mean that formats are lost if any one of the MHDD fail; the format 'groups' can be displayed on any MHDD by use of the display swap keys on the pedestal panel, refer to Multifunction Head down Display pag. 1-88. Certain formats (Table , "Default Format Displays," on page 1-61) are defined as default formats for particular POF, and are automatically displayed upon entry into that POF. Any format can be selected at any time via the MHDD soft-keys appropriate for that MHDD format group.

The MHDD formats shown in Figure 1.43 to Figure 1.58 are to be considered as 'typical examples' of the system information that can be displayed.

Symbol Generation

The MHDD formats are produced by the Computer Symbol Generator (CSG). There are two CSG, each capable of driving up to six MHDD and two HUD. Only one CSG is on-line at any one time, the other CSG is in standby mode just in case the on-line CSG fails. The CSG in standby can be chosen as the on-line CSG by selecting the REV (reversionary) position of the CSG toggle switch located on the right forward console. The output of the selected CSG is transmitted to the MHDD via dedicated video links. For additional information, refer to Computer Symbol Generator pag. 1-117.

Soft-key legends are generated by the Cockpit Interface Unit (CIU). When a soft-key option is selected it is transmitted by the CIU to the relevant system via the cockpit and avionic databuses.

Failure

In the event of a MHDD failure, it is possible to transfer the displays from the failed MHDD to the remaining operational MHDD using the display change selector/indicators on the pedestal panel.

Formats

The three MHDD provide the primary display for a number of systems and allow control selections for some systems to be made. The information is organized into the following formats:

– Attack (ATCK)
– Autocue (ACUE)
– Checklist (CHKL)
– Defensive Aids Sub System (DASS)
– Digital Map Generator (DMG)
– Disorientation Recovery Format (DRF)
– Elevation (ELEV)
– Engines (ENG)
– Fuel (FUEL)
– Head down HUD (HDHUD)
– Horizontal Situation Indicator (HSI)
– Hydraulics (HYD)
– Maintenance (MNTC)
– Pilot Awareness (PA)
– Radios (FREQ)
– Stores (STOR)
– Waypoint (WPT)
– Warnings (W).

In each POF the left and right MHDD formats are automatically selected for display by default. The formats for each POF are given in Table , "Default Format Displays," on page 1-61. The soft-keys enable options associated with each format, or selection of other display formats.

Default Format Displays

PHASE OF FLIGHT SELECTED	FORMATS DISPLAYED UPON ENTRY LEFT MHDD	FORMATS DISPLAYED CENTER MHDD	FORMATS DISPLAYED UPON ENTRY RIGHT MHDD
Ground	ACUE	PA	ENG/STOR*
Take Off	ATCK	PA	ENG
Navigation	ATCK	PA	ELEV
Air to Air Combat	ATCK	PA	ELEV
Approach and Landing	ATCK	PA	ENG
* ENGINE FORMAT INITIALLY, FOLLOWED BY STORES FORMAT WHEN THE MASS IS SET TO STBY OR LIVE			

The MNTC format is used for ground maintenance and can only be selected from the autocue format. The autocue format is only available on the ground. Formats are displayed on specific MHDD. Detailed information for each format/MHDD is given in the following Tables:

– Ground Procedures Formats - Table , “Ground Procedures Formats,” on page 1-62
– Take Off Formats - Table , “Take Off Formats,” on page 1-62
– Navigation Formats - Table , “Navigation Formats,” on page 1-63
– Air to Air Combat Formats - Table , “Air to Air Attack Formats,” on page 1-63
– Approach and Landing Formats - Table , “Approach and Landing Formats,” on page 1-64 .

Ground Procedures Formats

LEFT MHDD	CENTER MHDD	RIGHT MHDD
* Autocue[9]	* Pilot Awareness	* Engines, Stores, Engines (initially), Stores (when MASS is set to standby or live)
HDHUD[7]	Disorientation Recovery[2]	HDHUD
Attack		Elevation
Maintenance[3]		DASS
Checklist[1]		Reversionary
Engines[10]		Checklist[8]
Fuel[1]		Engines[5]
Hydraulics[1]		Fuel
Stores[1]		Hydraulics
		Radios
		Waypoints
		Stores[6]
		Warnings[4]

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] From the Autocue

[4] Only when there is a warning

[5] When Stores is the default format

[6] When Engines is the default format

[7] From the Attack format

[8] When there is not a warning

[9] Default if pre-flight. Only available when the undercarriage selection is not UP

[10] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

Take Off Formats

LEFT MHDD	CENTER MHDD	RIGHT MHDD
* Attack	* Pilot Awareness	* Engines
HDHUD	Disorientation Recovery[2]	HDHUD
Autocue[6]		Elevation
Checklist[1]		DASS
Engines[5]		Reversionary
Fuel[1]		Checklist[4]
Hydraulics[1]		Fuel
Stores[1]		Hydraulics
		Radios
		Waypoints
		Stores
		Warnings[3]

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] Only when there is a warning

[4] When there is not a warning

[5] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

[6] Default if an Autocue CAUTION or NOGO and the undercarriage selection is not UP. Only available with WOW

Navigation Formats

LEFT MHDD	CENTER MHDD	RIGHT MHDD
* Attack	* Pilot Awareness	* Elevation
HDHUD	Disorientation Recovery[2]	HDHUD
Autocue[6]		DASS
Checklist[1]		Reversionary
Engines[5]		Checklist[4]
Fuel[1]		Engines
Hydraulics[1]		Fuel
Stores[1]		Hydraulics
		Radios
		Waypoints
		Stores
		Warnings[3]

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] Only when there is a warning

[4] When there is not a warning

[5] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

[6] Default if an Autocue CAUTION or NOGO and the undercarriage selection is not UP. Only available with WOW

Air to Air Attack Formats

LEFT MHDD	CENTER MHDD	RIGHT MHDD
* Attack	* Pilot Awareness	* Elevation

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] Only when there is a warning

[4] When there is not a warning

[5] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

LEFT MHDD	CENTER MHDD	RIGHT MHDD
HDHUD	Disorientation Recovery[2]	HDHUD
Checklist[1]		DASS
Engines[5]		Reversionary
Fuel[1]		Checklist[4]
Hydraulics[1]		Engines
Stores[1]		Fuel
		Hydraulics
		Radios
		Waypoints
		Stores
		Warnings[3]

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] Only when there is a warning

[4] When there is not a warning

[5] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

Approach and Landing Formats

LEFT MHDD	CENTER MHDD	RIGHT MHDD
* Attack	* Pilot Awareness	* Engines
HDHUD	Disorientation Recovery[2]	HDHUD
Autocue[6]		Elevation
Checklist[1]		DASS
Engines[5]		Reversionary
Fuel[1]		Checklist[4]
Hydraulics[1]		Fuel
		Hydraulics
		Radios
		Waypoints
		Stores
		Warnings[3]

* Default

[1] From the Warnings format on the Right MHDD

[2] From the selection of Auto Recovery

[3] Only when there is a warning

[4] When there is not a warning

[5] From the HDHUD format on the Left MHDD or from the Warnings format on the Right MHDD

[6] Only available when the undercarriage selection is not UP

NOTE

The right MHDD provides an option to select either the checklist, engines, fuel, hydraulics and stores format for display on the left MHDD. When an option is selected, the displayed format on the left MHDD, replaces the current display until it is deselected or an alternative selection is made on the right MHDD.

General Format Symbology

In most cases, if information is presented in an analog format (e.g. thermometer scales or counter pointers), a digital readout is also presented. Red is used to indicate warnings or failure conditions requiring immediate action, e.g. hostile track; amber indicates cautionary conditions, e.g. unknown track; and green or white indicates correct or satisfactory conditions, e.g. friendly track. Flashing symbology is used to alert the aircrew to:

– A change in priorities, e.g. a change in target/ track order of threat priority
– An illegal action, e.g. an unacceptable stores jettison program
– An action can not be achieved, e.g. an AMRAAM that will not reach the target.

Attack Format

The Attack (ATCK) format together with HOTAS controls, enable sensor contacts to be displayed, tracked or nominated for attack. During operation in Track While Scan (TWS) mode radar contacts are displayed against one of two selectable range/ azimuth display formats. The default format is a B-scope grid type presentation (Figure 1.43). Radar scan volume is indicated against the grid by three vertical lines which together represent scan width and center and by a scanner elevation scale against which current bars scan pattern and coverage is displayed. For additional information, refer to Radar pag. 1-482.

Soft-key selection enables the display to be changed to a Plan Position Indication (PPI) type presentation if required (Figure 1.44). When PPI is selected, radar contacts are displayed against a sector upon which range is indicated by arcs.

A Velocity Search (VS) mode is provided as an alternative to TWS and is accessed by soft-key selection (Figure 1.45). When in VS mode radar plots are shown against a velocity azimuth type display.

Autocue Format

The Autocue (ACUE) format (Figure 1.46) supports preflight activities by presenting the information necessary for safe preparation of the aircraft for its intended task. The following types of data are presented:

– Control prompts (switch settings)
– Flight control system status
– Navigation system status
– Caution indications
– Failure indications
– Store error indications
– Displays and controls error indications
– Portable Data Store (PDS) load indications
– Cryptovariable indications
– Command eject indications
– Operational status indications.

The soft-keys associated with the ACUE format enable the required LINS alignment mode and LINS NAV mode to be selected.

Checklist Format

The Checklist (CHKL) format provides the aircrew with a list of standard and emergency checklists from which the required drill can be selected.

Standard Checklist

The standard checklists provide the aircrew with the drills required to perform normal aircraft and systems checks, refer to Figure 1.60 .

Emergency Checklist

The emergency checklists provide the aircrew with the emergency drills required to perform aircraft and system checks for abnormal operation, refer to Figure 1.61.

Procedures and Consequences

The procedures and consequences checklist provides the aircrew with the warning procedure/ consequence associated with the warning displayed on the DWP, refer to Figure 1.62 .

DASS Format

The Defensive Aids Subsystem (DASS) format displays range rings and targets relayed from the attack format, and the remaining number of chaff packages and flares, at the present software standard. The only DASS function currently available is the discharge of chaff and flares via HOTAS controls. For additional information, refer to Defensive Aids Subsystem pag. 1-579.

Elevation Format

The Elevation (ELEV) format, together with HOTAS controls, enables radar contacts to be displayed, tracked or nominated for attack. The contacts are displayed against one of two selectable formats; an altitude/range grid presentation known as ‘profile’ (Figure 1.47), or an altitude/azimuth grid presentation known as C-scope (Figure 1.48).

With the profile format selected the X-axis represents plan range in front of the aircraft while the Y-axis represents altitude. Scanner elevation coverage is displayed by two diverging lines and the pattern can be steered in elevation via a rotary control on the throttles.

The C-scope presentation displays azimuth on the X-axis while the Y-axis is used to display relative altitude. Scanner volume is displayed in both azimuth and elevation.

For additional information, refer to Radar pag. 1-482.

Engine Format

The Engine (ENG) format (Figure 1.49) displays engine low pressure turbine speed (NL) with Turbine Blade Temperature (TBT) and nozzle area (Aj) represented by four circular displays (two for each engine). Important values are displayed by either infill, digital or analog readouts. Each display has an alphanumeric value corresponding to the analog data presented, except for high pressure turbine speed which is represented by two separate rolling digit type displays. Intake positions are displayed, but only if auto cowl operation fails, by two triangular markers which move against a fixed linear scale and by digital readouts. The fuel flow is indicated in digital form at the top of the display. Warning captions related to the engines are also shown on this format, when applicable. For additional information, refer to Engine Operation pag. 1-146.

The soft-keys associated with the ENG format enable DECU lane selections to be made and other formats to be accessed.

Fuel Format

The FUEL format (Figure 1.50) displays the internal and external fuel tank contents pictorially. Each tank has a digital readout corresponding to the fuel remaining. Fuel transfer and boost pumps within the internal fuel tanks are displayed. The status of the low pressure fuel cocks is indicated by two symbols, each comprising a bar within a circle.

Engine feed lines are drawn between the boost pumps and the LP fuel cock symbols. Fuel feed temperatures are indicated in digital form adjacent to the LP cock symbology.

Other information displayed on the fuel format includes a fuel total readout, CG warnings and a transfer selector prompt to show the recommended selection to restore fuel balance. For additional information, refer to:

– Fuel System pag. 1-171
– Fuel System pag. 1-189.

Head Down HUD Format

The Head Down HUD (HDHUD) format (Figure 1.51) presents analog and digital readouts as presented on the head-up display (HUD) except for the symbology color. Symbology presented on the format is categorized as follows:

– Attitude and directional symbology
– Navigation symbology
– Air data symbology
– Attack symbology.

The main difference between the two displays is that the HDHUD format has a circular display in addition to the HUD climb/dive bars. The circular display is

divided into two sectors, one colored blue and the other brown, indicating climb or dive above and below the horizon respectively.

Under certain sensor failure conditions, the display will change to show the pitch attitude above and below the horizon. This change is indicated by the aircraft 'climb/dive' symbol changing to an 'attitude' symbol. These symbols are fixed at the display center with the circular display moving around them.

Hydraulics Format

The Hydraulics (HYD) format (Figure 1.52) provides a diagrammatic representation of the left and right hydraulic systems. The display shows the status of the valves and reservoirs along with associated information e.g. pressures, levels and temperatures. The information is displayed in analog and digital form.

Reservoir contents, flight control pressures and utilities pressures are displayed. If a system pressure or reservoir content within the hydraulic system falls below the safe level the associated box(es) are displayed in red and the digital readout(s) of actual contents will be displayed against a red infill.

The status of the utility isolation valves is indicated by two symbols, each comprising a bar within a circle. An AUTO or MAN caption is displayed adjacent to the symbols to indicate whether the valves are being controlled automatically (by the hydraulic system) or manually (via soft-key selection). For additional information, refer to Hydraulic Power Supply System pag. 1-214.

Pilot Awareness Format

The Pilot Awareness (PA) format (Figure 1.53) displays navigational information in plan form. The symbology can be displayed against a digitally generated map and one of four selectable grids; range, lat/long, geographical reference or bullseye. The PA format also presents track/target data and a limited amount of miscellaneous information to assist the pilot to manage the aircraft safely. The display is active and therefore gives an up to date representation of aircraft positioning at all times.

Radio Format

The radio (FREQ) format (Figure 1.54) presents the V/UHF frequencies for the manual channel and the 24 preset channels for radios 1 and 2. The data is presented in the form of two mutually exclusive lists one covering radio 1 details and the other covering radio 2, however, the format always displays manual channel data for both radios. For additional information, refer to Communication Equipment pag. 1-396.

Stores Format

The Stores (STOR) format (Figure 1.55) provides a diagrammatic representation of weapon system status and current stores configuration. Stores are represented by white outlined symbols at positions relative to their host store station. Stores are selected for jettison by performing an X-Y insert over the appropriate store symbol(s). For additional information, refer to Stores pag. 1-615.

Warnings Format

The Warnings format displays the warnings which are applicable during flight and, by soft-key selection, the procedures and consequences for them.

When the warnings format is selected, the highest priority warning will be displayed. The priority of a warning is based on whether it has been acknowledged, its category and time of occurrence.

Waypoint Format

The Waypoint (WPT) format (Figure 1.56) is able to present information associated the master waypoint list, the automatic route, and the manual route in the form of three separate waypoint lists. The lists are mutually exclusive and can be accessed by selection of three soft-keys labelled WPT LIST, AUTO RTE and MAN RTE.

Maintenance Format

The maintenance format provides, via the autocue format, the facility to make IBIT selections for ground maintenance functions. This format is not available when the aircraft is in motion or the ejection seat(s) is armed.

Disorientation Recovery Format

The Disorientation Recovery Format (DRF) (Figure 1.57) displays a decluttered HDHUD format on the center MHDD to aid pilot awareness of the recovery. When the aircraft achieves stable conditions, fulfilling the DRF requirements, the FCS will automatically engage the autopilot. The MHDD display formats will then revert back to their previously selected formats prior to the selection of the DRF.

Horzontal Situation Indicator Format

The Horizontal Situation Indicator (HSI) format (Figure 1.58) displays the following TACAN or navigation system derived data:

- Compass Rose
- Plan Range (Nav mode)
- Slant Range (TACAN mode)
- Bearing Pointer

- Course Readout
- Course Pointer
- Heading Marker
- Autopilot Demanded Heading
- Current Aircraft Track Pointer
- Lateral Deviation and Scale
- To/From Flag
- Current Destination Waypoint Number (Nav mode)
- TACAN Channel Number and Type (TACAN mode)
- TACAN Mode Indication (TACAN mode).

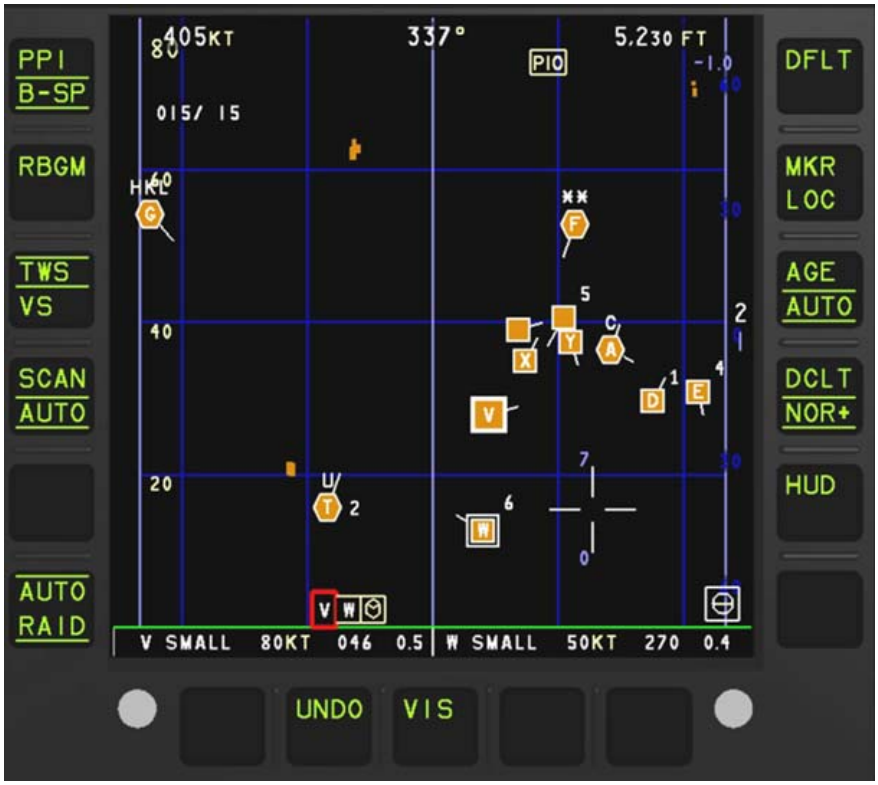


Figure 1.43 - Typical Example of B Scope Attack Format

Figure 1.44 - Typical Example of PPI Attack Format

Figure 1.45 - Typical Example of Velocity Search Attack Format

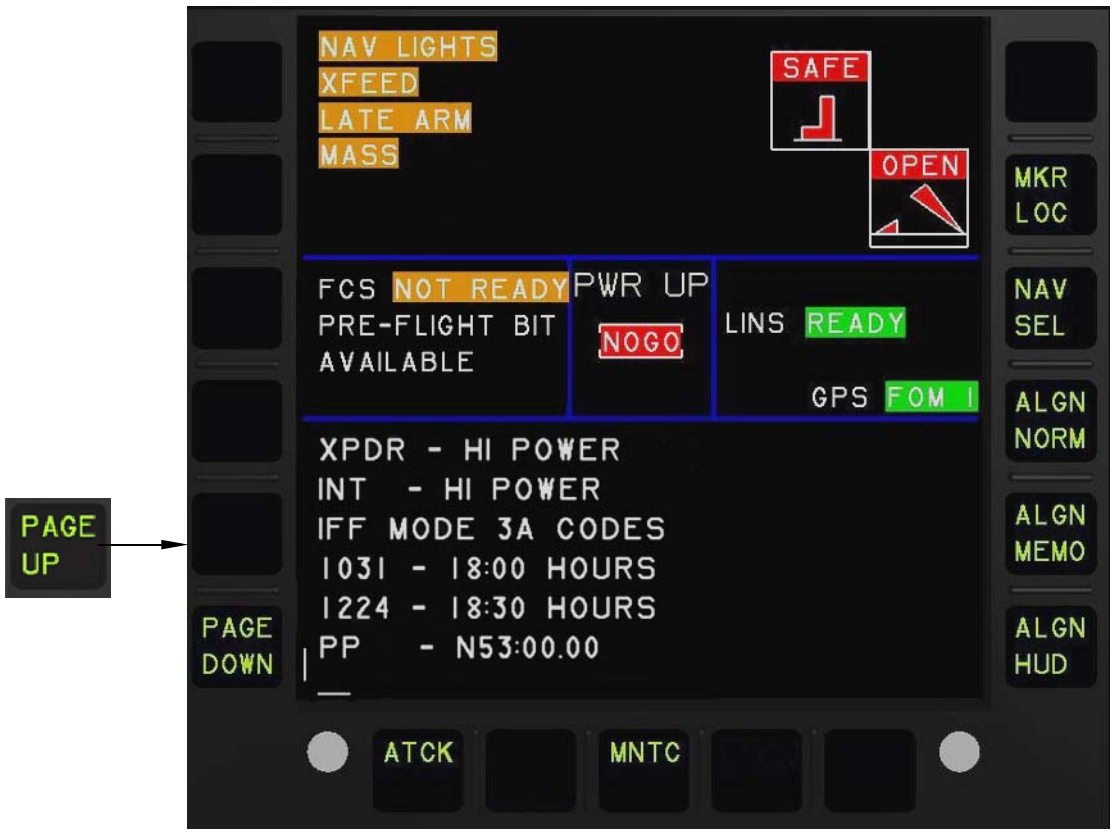


Figure 1.46 - Typical Example of Autocue Format

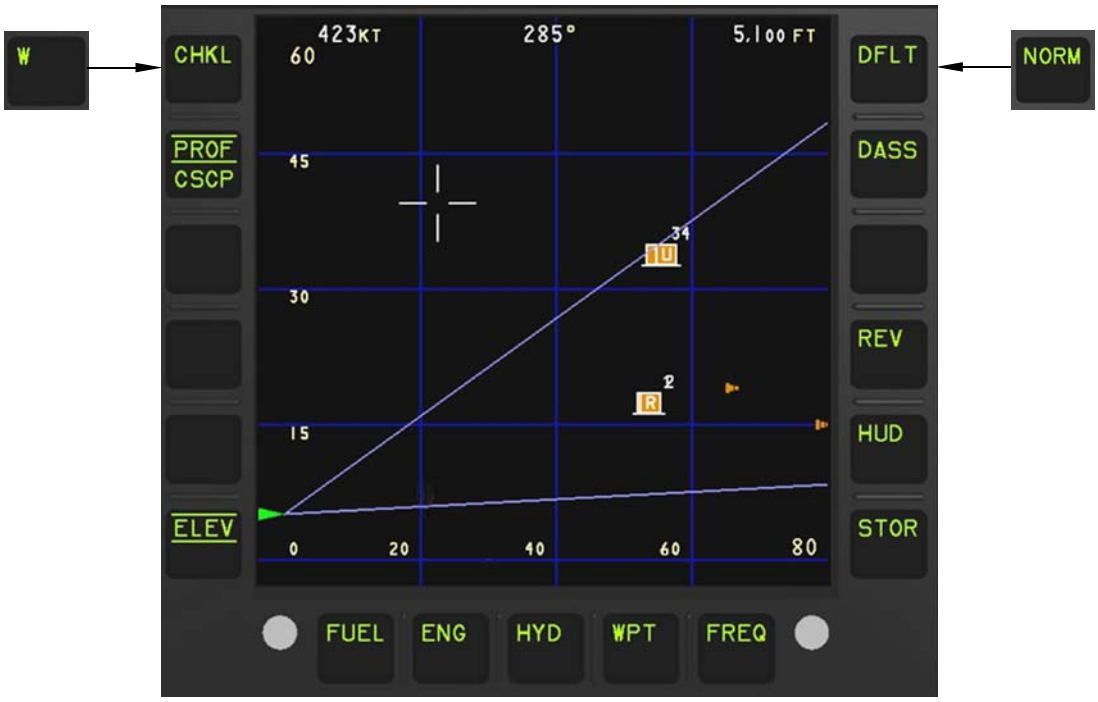


Figure 1.47 - Typical Example of Profile Elevation Format

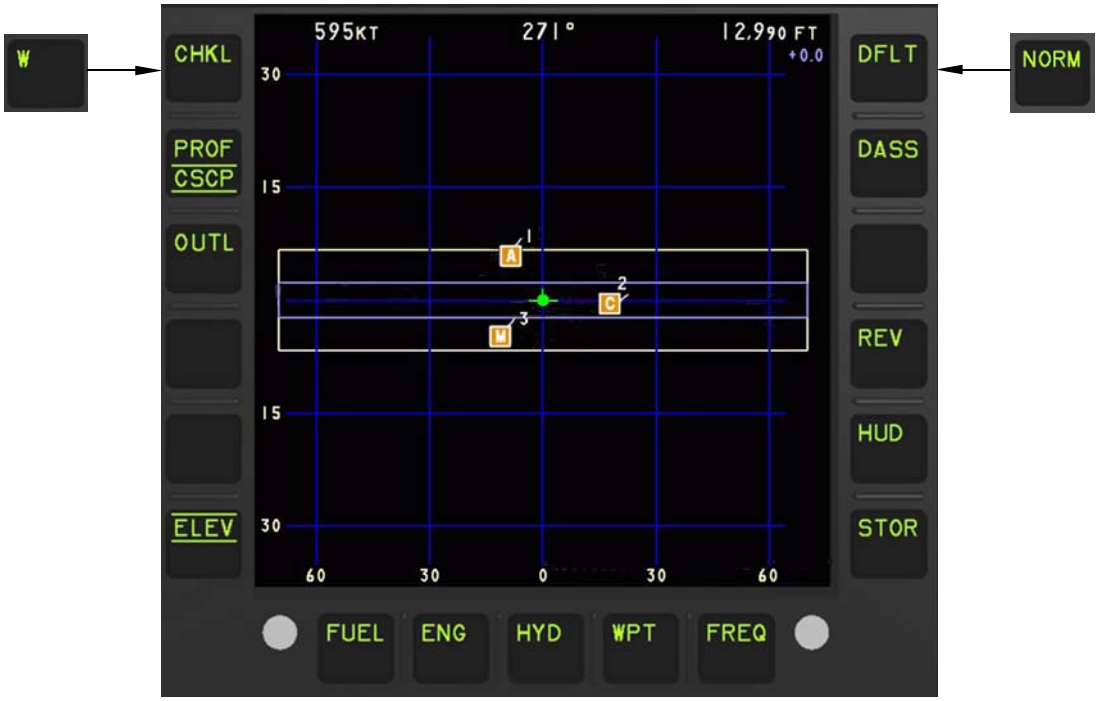


Figure 1.48 - Typical Example of C Scope Elevation Format

Figure 1.49 - Typical Example of Engines Format

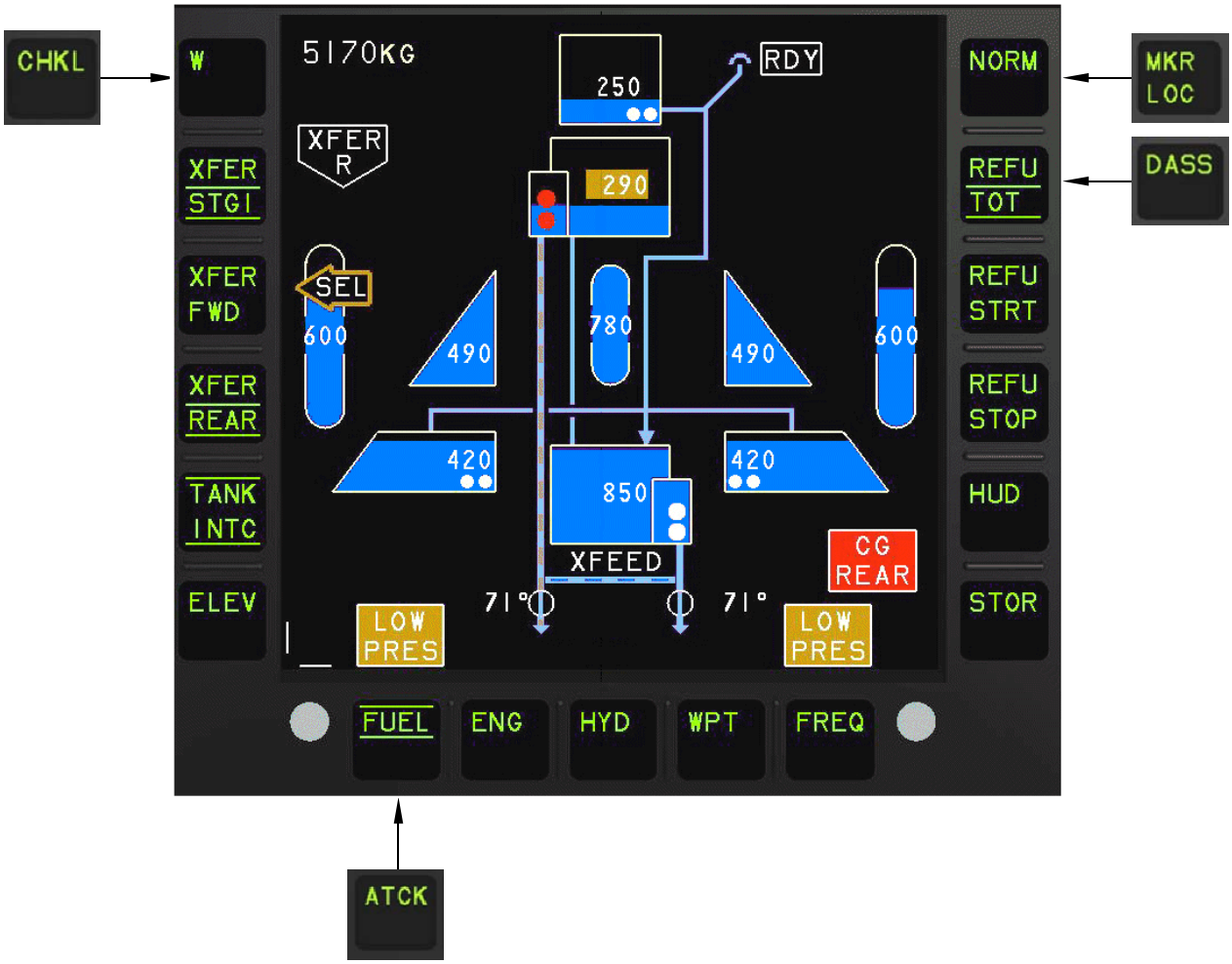


Figure 1.50 - Typical Example of Fuel Format

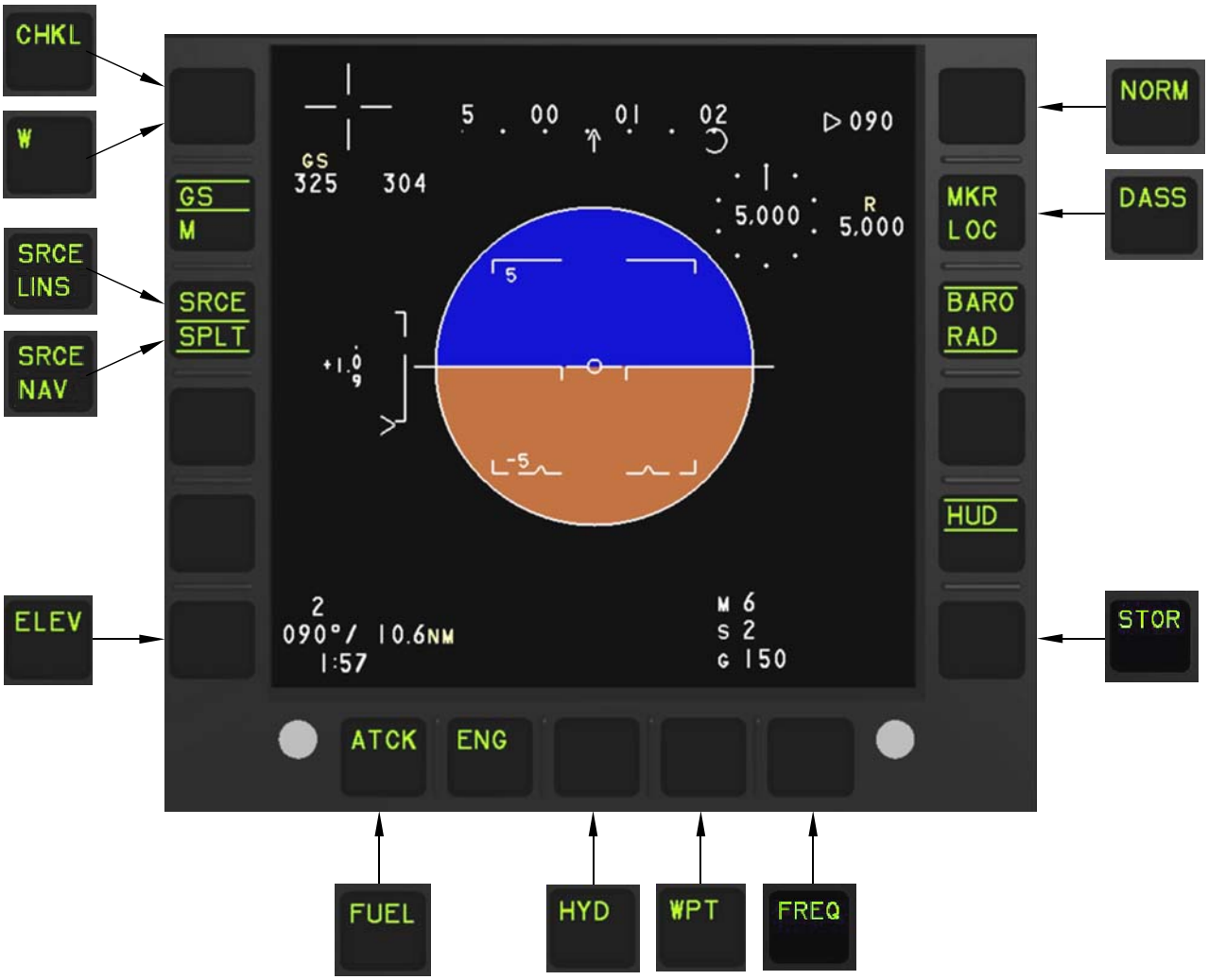


Figure 1.51 - Typical Example of Head Down HUD Format

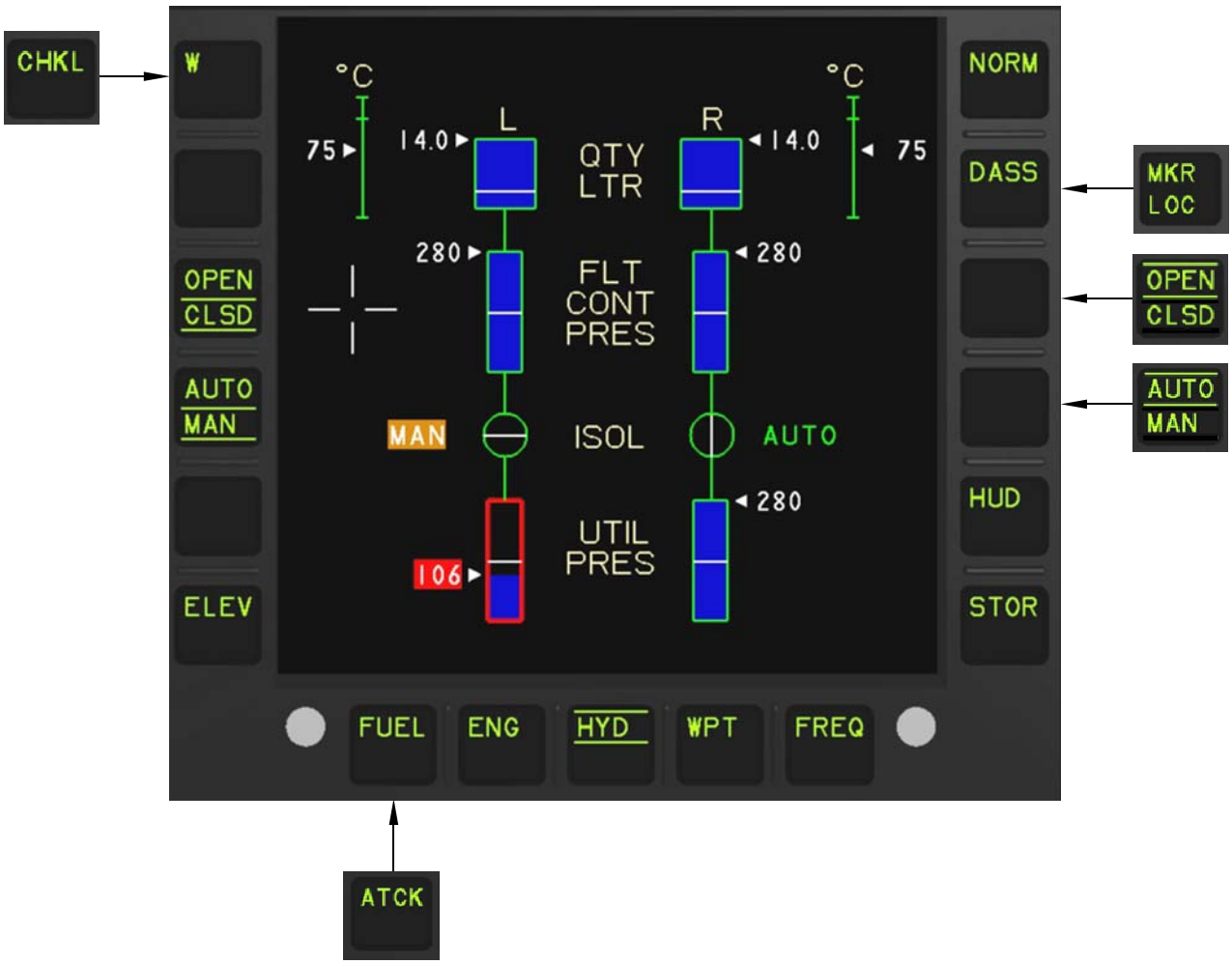


Figure 1.52 - Typical Example of Hydraulics Format

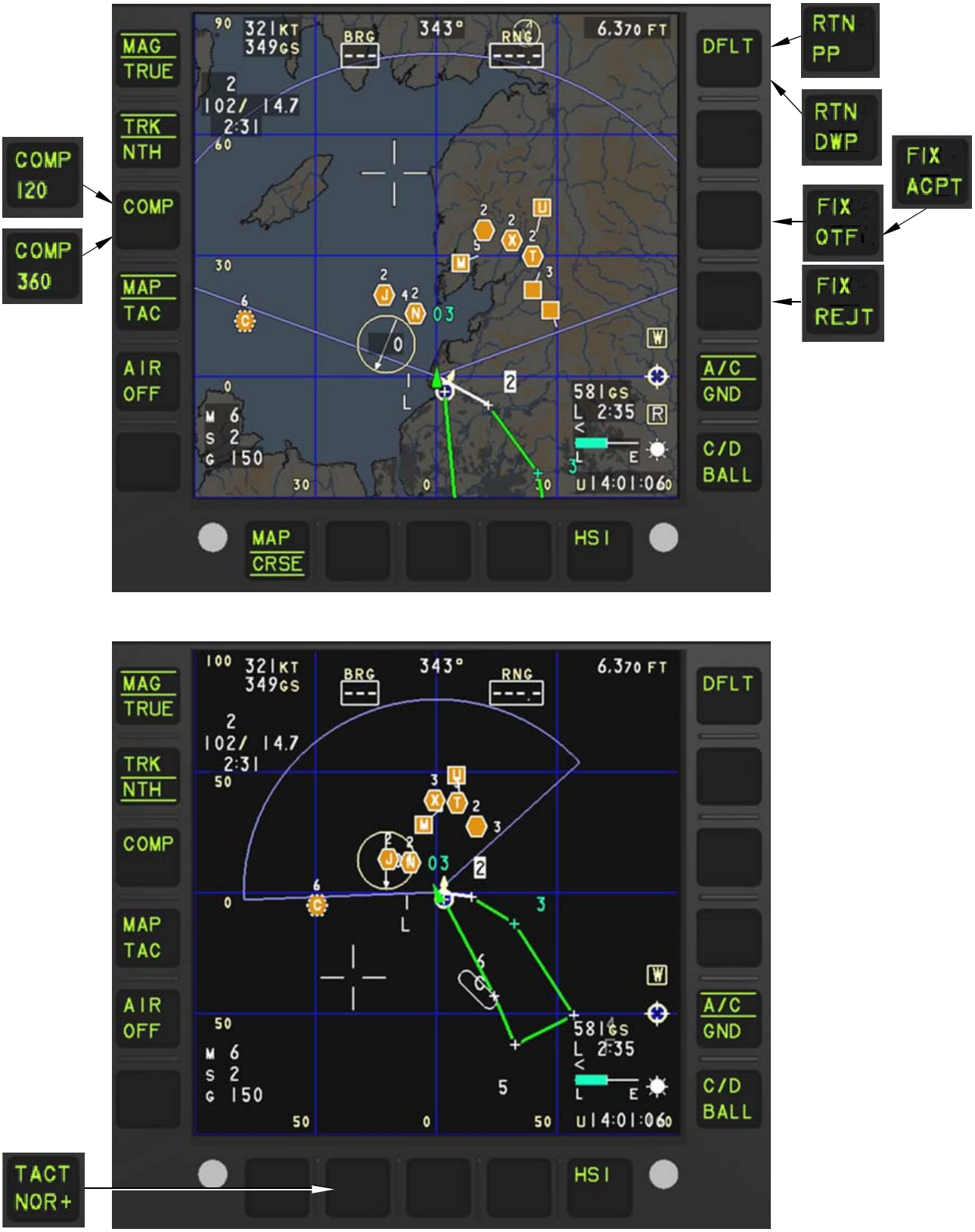
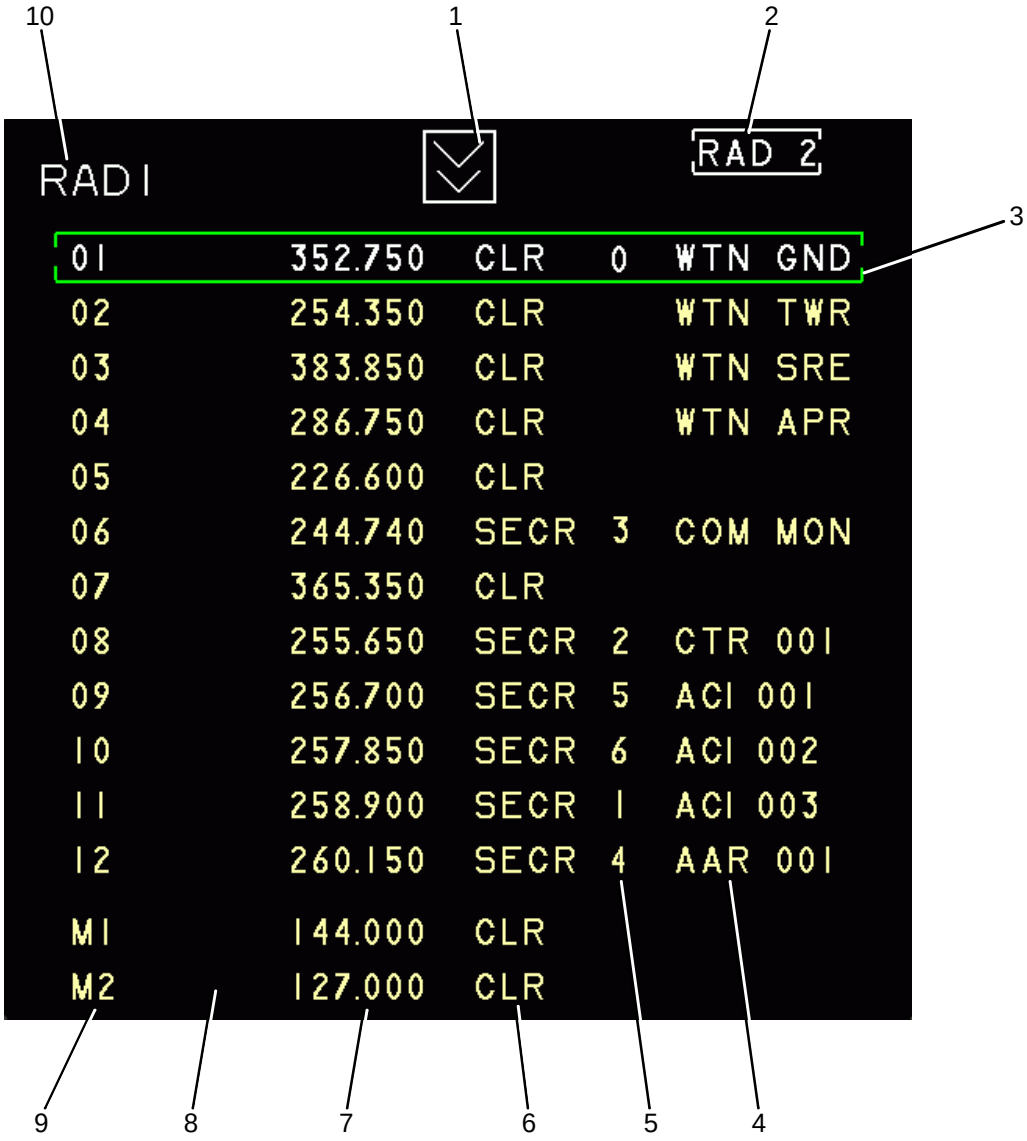


Figure 1.53 - Typical Example of Pilot Awareness Format



1 PAGE UP/DOWN ICON
2 RADIO SELECT ICON (EITHER RAD1 OR RAD2)
3 CURRENT CHANNEL IN USE (WITH ADDITIONAL INFORMATION)
4 CHANNEL IDENTIFIER
5 KEY OF DAY
6 CLEAR/SECURE STATUS
7 CHANNEL FREQUENCY
8 FREQUENCY HOPSET COLUMN (NATO OR NON-NATO)
9 CHANNEL NUMBER (M = MANUAL)
10 SELECTED RADIO (EITHER RAD1 OR RAD2)

Figure 1.54 - Typical Example of Radios Format

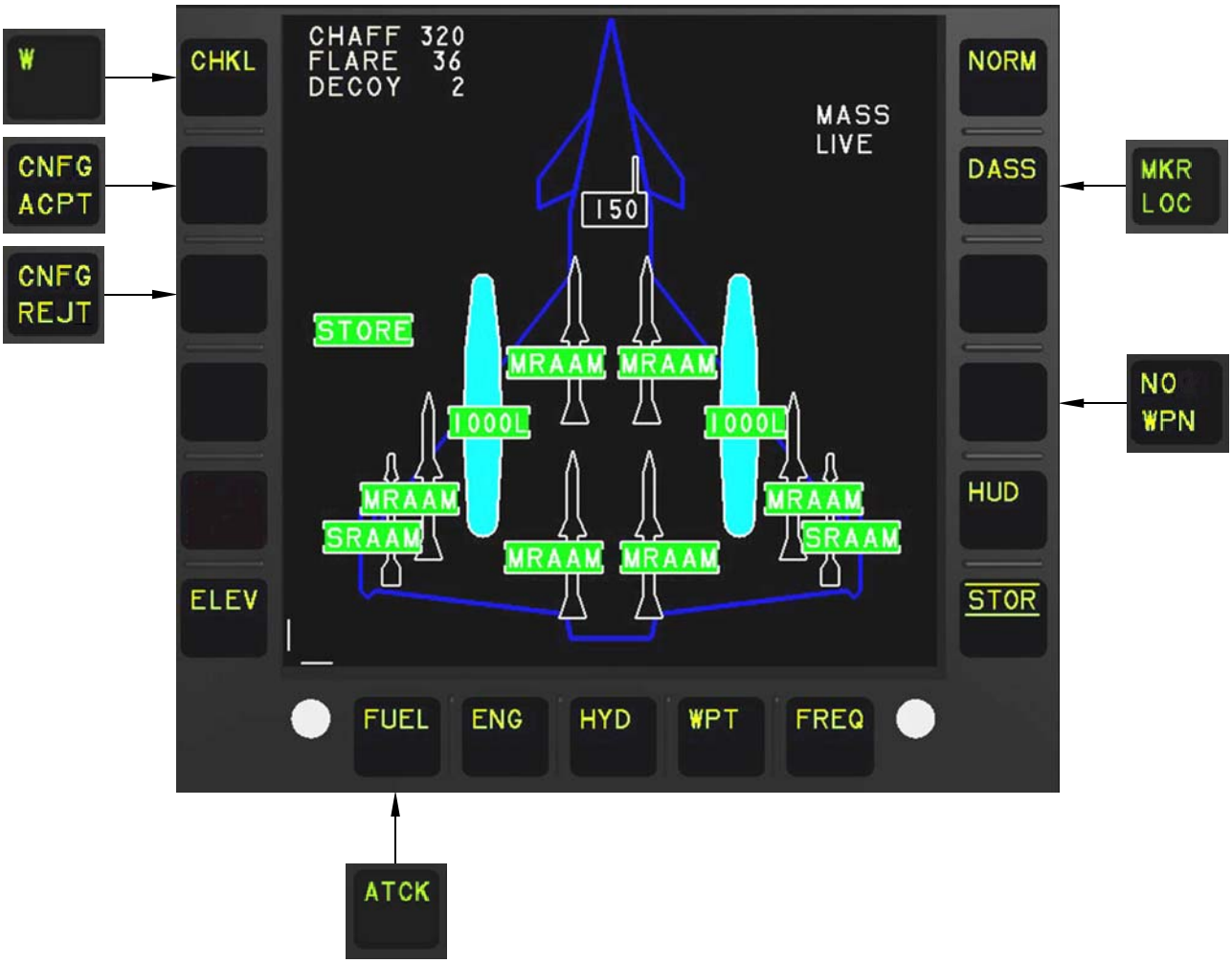


Figure 1.55 - Typical Example of Store Format

Figure 1.56 - Typical Example of Waypoint Format

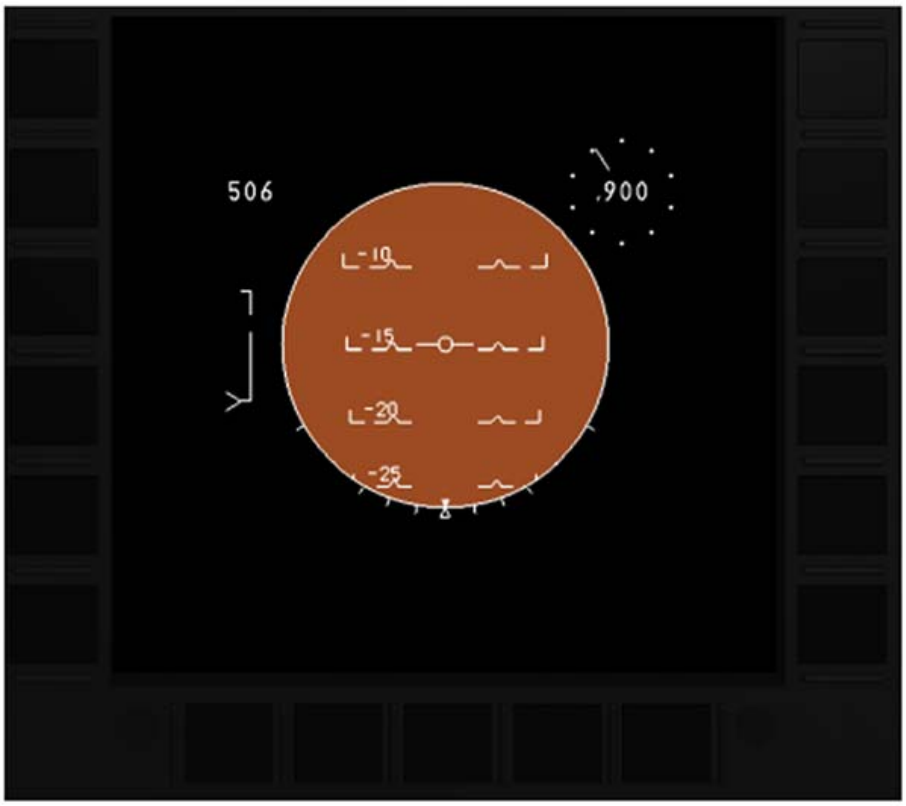


Figure 1.57 - Typical Example of Disorientation Recovery Function Format

Figure 1.58 - Typical Example of Horizontal Situation Indicator Format

Figure 1.59 - Typical Example of Checklist Format

Figure 1.60 - Typical Example of Checklist Format - Normal Procedures

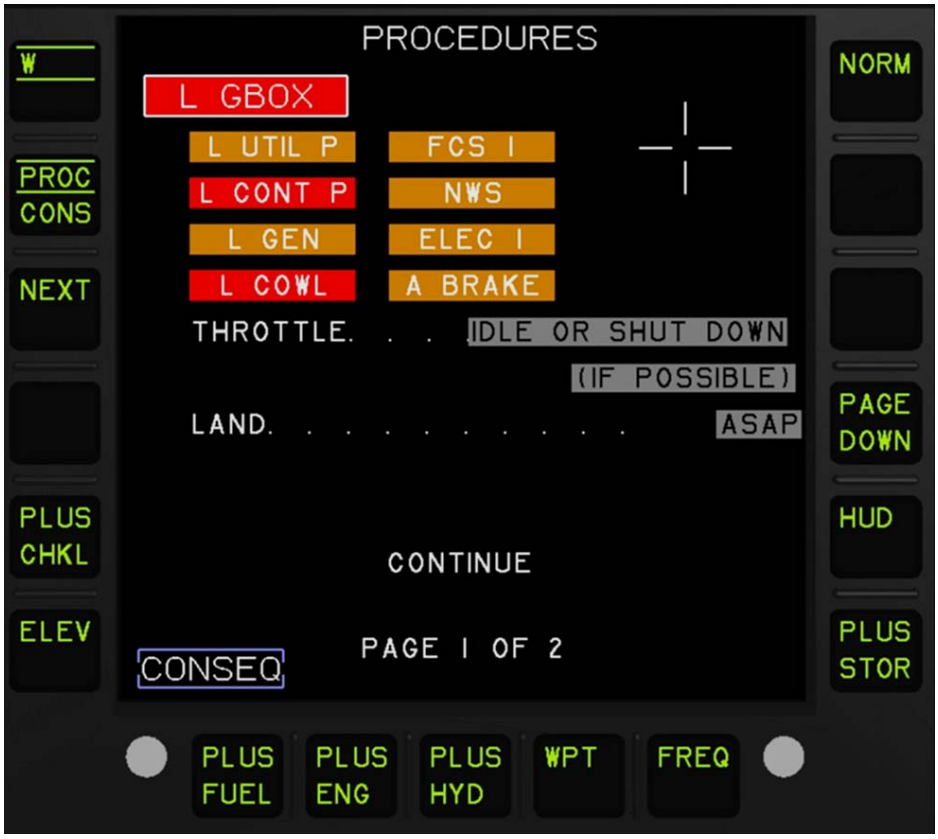


Figure 1.61 - Typical Example of Checklist Format - Emergency Procedures

Figure 1.62 - Typical Example of Checklist Format - Consequences

Multifunction Head down Display

(1B-B-31-15-00-00A-111A-A Issue 003)

Introduction

There are four sets of controls and indicators associated with the MHDD:

– Display controls
– Soft-keys
– MHDD format interchange controls
– POF selectors

MHDD Display Controls

The MHDD display controls, (see Figure 1.63) consist of two rotary controls, two rocker switches and a power ON/OFF switch.

Rotary Controls

The two rotary controls control the following functions:

– The left control knob controls the movement of the HSI heading marker around the compass rose when the HSI display is selected from the Pilot Awareness (PA) format. Rotation of the control, clockwise from the center detent position, causes the heading marker to rotate clockwise and vice versa. Positioning the rotary control to the center detent position stops heading marker rotation.
– The right control knob controls either, the movement of the HSI course marker when the HSI format is selected (center MHDD) , or the radar/map balance when the attack format (left MHDD) is selected.

Rocker Switch Controls

The two rocker switches control the display brightness and balance as follows:

– The left rocker switch controls the display brightness
– The right rocker switch controls the cursive/ raster, i.e. foreground/background, balance.

Power Switch

The power ON/OFF switch is located on the top bezel of the MHDD.

Soft-keys

There are 17 soft-keys located on the bezel surrounding the display, which enable the aircrew to select modes or data for display. The soft-keys are push button selectors containing a matrix of LED, which allows the key legend to vary according to the function it controls. The soft-key functions vary according to the format being displayed.

Display Change Selector/Indicators

Three push button selector/indicators, labelled DISP CHANGE, (see Figure 1.64), located on the pedestal panel, allow the aircrew to swap format groups between MHDD. The momentary action push button controls have a double-headed arrow legend, and illuminate to indicate which MHDD will swap when the button is pressed, i.e. left and center, right and center, and left and right.

POF Selector/Indicators

Much of the automation of cockpit and displays moding is performed as a function of POF. The POF currently selected is indicated on the pedestal panel by the ‘boxing’ of the POF legend. There are five POF buttons, one for each phase, as listed. Usually, POF is selected automatically by the avionic systems, as a result of some other action, but the aircrew can manually select any POF, except A-A, at any time by pressing the relevant POF button. A-A POF is selected/deselected automatically, although it is deselected if the aircrew manually select another POF.

– Ground procedures (GND)
– Takeoff (T/O)
– Navigation (NAV)
– Approach and landing (LDG)
– Air-to-Air (AA) is an indicator only.

Ground (GND)

The GND POF is divided into two phases. The system enters Ground 1 POF automatically on initial power-up, and goes automatically to Ground 2 POF when the parking brake is first selected OFF. If the pilot selects Ground POF manually via the GND push button on the pedestal panel, the system will automatically select the appropriate phase.

Takeoff (T/O)

The T/O POF is enabled either by selecting the MASS to LIVE or Weight Off Wheels or opening both throttles to a position equivalent to or greater than 80% NL RPM.

Navigation (NAV)

The NAV POF is enabled when the landing gear is selected UP.

Combat (A-A)

The system will automatically select Air-to-Air (AA) combat POF when the pilot selects an AA weapon

using the Air-to-Air Weapon Selector on the pilot's control stick and a target has been nominated.

Approach and Landing (LDG)

The LDG POF is automatically selected when the landing gear is selected DOWN.

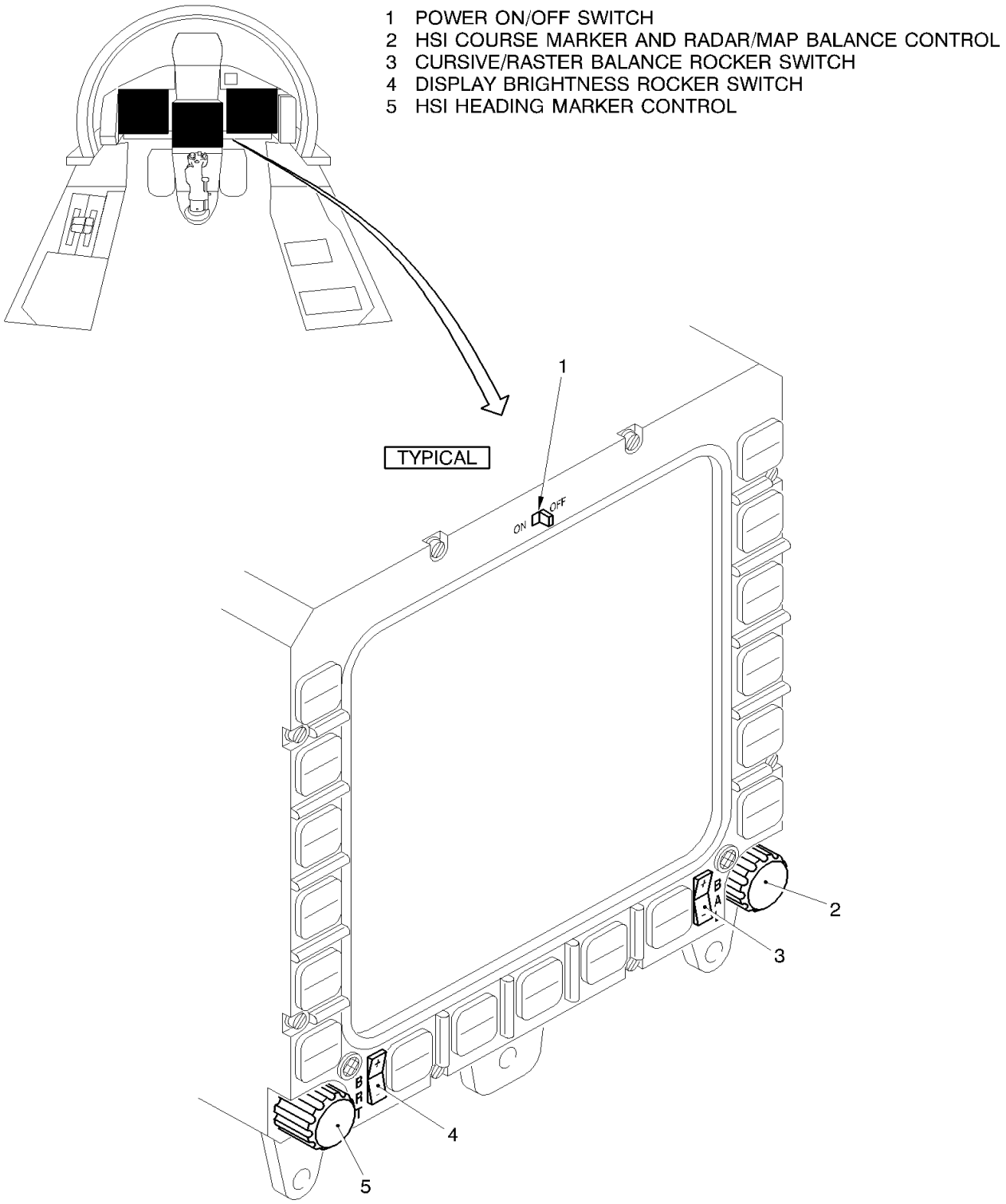


Figure 1.63 - MHDD Display Controls

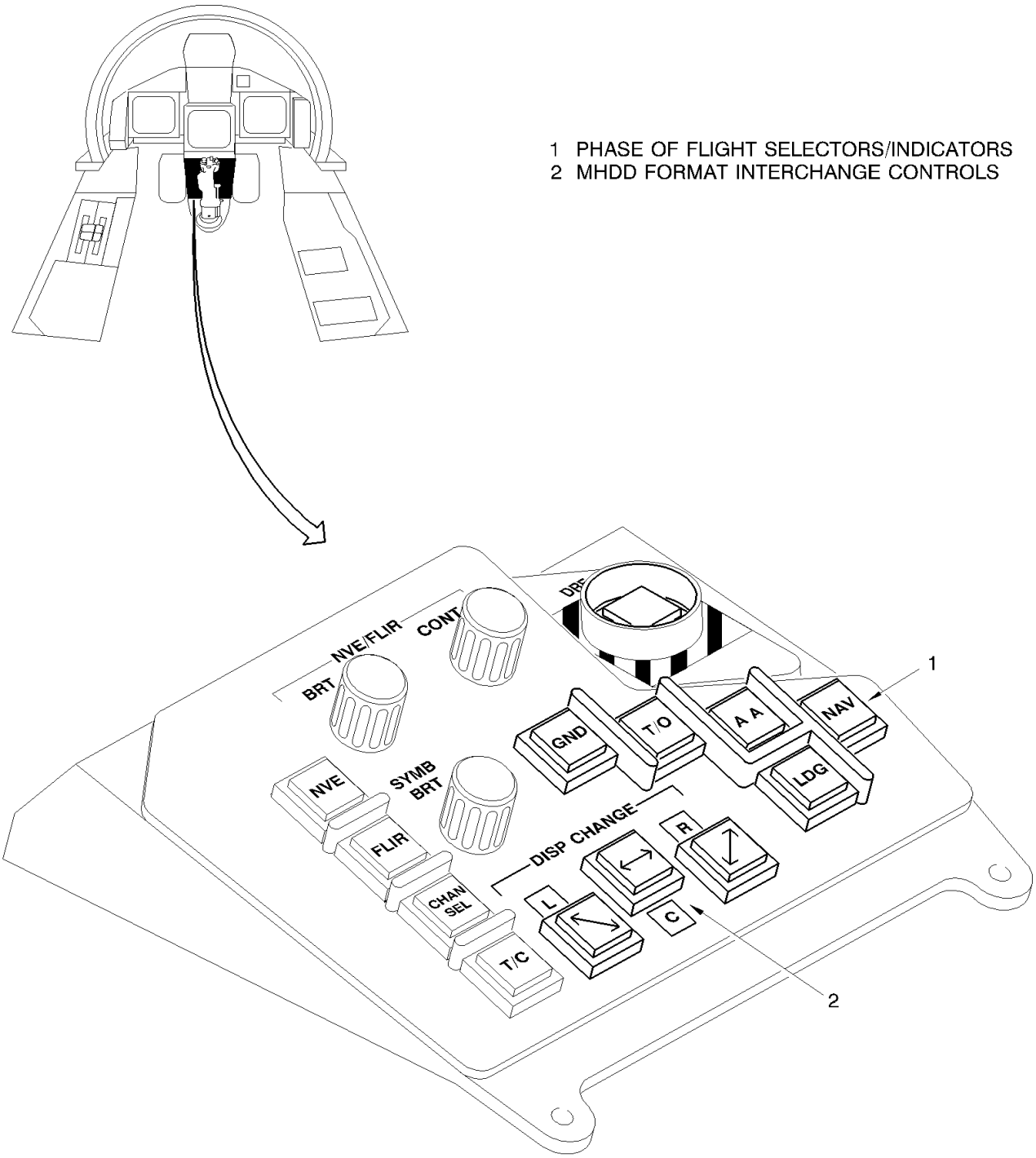


Figure 1.64 - Pedestal Panel Controls and Indicators

Manual Data Entry

(1B-B-31-11-00-00A-043A-A Issue 002)

Introduction

The Manual Data Entry Facility (MDEF) is located on the left glareshield and is part of the Displays and Control (D&C) system. It is used for moding and data entry to several avionic systems. The MDEF consists of the following (Figure 1.65):

– Subsystem keys
– Moding keys
– Read Out Line (ROL)
– Toggle switch
– Data entry keyboard (DEK)
– Destination waypoint (DWP) ROL
– Change destination (CHD) push button.

Subsystem Keys

There are thirteen subsystem keys; the set waypoint key (SWP) is located separate to the other keys. The MIDS, A/S and NIS keys currently have no function. The subsystem keys allow moding and data entry to the following functional groups, called the MDEF subsystems.

– Navigation (NAV)
– Navigation aids (AIDS)
– IFF interrogator (INT)
– IFF transponder (XPDR)
– Radar transmitters (XMIT)
– Radio 1 (RAD1)
– Radio 2 (RAD2)
– Defensive aids (DAS)
– Miscellaneous (MISC)
– Set waypoint (SWP).

Selection of a subsystem is indicated by the illumination of bars above and below the key's legend. Initially on applying power no subsystem will be selected. On selection, the default displays and optional functions for that subsystem are displayed in the ROL, on the moding keys and the data entry keys. These remain illuminated until the subsystem is deselected by pressing the key again. On selection of a subsystem, the previously selected subsystem is automatically deselected. Another subsystem can be selected prior to completing the necessary data entries, however, the data entered is not passed to the subsystem or retained in memory.

Moding Keys

There are twelve moding keys, each key consists of two rows of four multifunction characters. The legend displayed on the key describes the function of that mode. The moding keys have three functions:

1 To indicate the current functional status of the selected subsystem

2 To enable the functional state to be changed

3 To allow subsystem data to be entered or edited via the DEK/ROL.

Where two modes are presented on one moding key e.g. TRK/DIR, horizontal bars (boxing) will be displayed above and below the legend indicating which mode has been selected. The alternative mode may be selected by pressing the key, the bars above and below the legend will move to 'box' the new selection. To return to the original mode the key must pressed again.

Where one mode is identified by two legends on a key e.g. 'EDIT RTE', a bar will be displayed above the upper legend and below the lower legend.

Some moding keys are used to indicate which data input mode is currently selected. When a data input mode is selected, either the current or default data is displayed in the ROL, and the DEK displays the relevant alphanumeric characters and symbols required for the data entry.

Selection of certain moding keys may present data on other aircraft displays and also allow data entries/ changes by use of the X-Y controller on the top of the right throttle.

Read Out Lines

The ROL are displayed on a four row by 13 column display. On selection of a moding key it displays either subsystem status information or the current/ default data for the option selected when applicable. The current data displayed in some cases can be overtyped. Where no system data exists dashes are displayed where data input is required/possible. The data for some moding key selections requires more than one page of ROL information; this is indicated by a page number on the right side of the bottom row. A writer marker is automatically positioned in the ROL under the first character that can be changed. Repositioning of the writer marker is achieved by use of the toggle switch.

Toggle Switch

The toggle switch is a five position center biased switch, which is used to position the writer marker under a variable in the ROL. The toggle switch can also be used to move between pages of a multi-page display.

Data Entry Keys

The data entry keyboard consists of eighteen multifunction keys and the dedicated clear (CLR) and enter (ENT) keys. Each of the multifunction keys can display an alphanumeric character or symbol.

The symbols that can be displayed are up, down, left and right arrows, and hash (#).

The characters on the keys, and the position of the writer marker in the ROL, are configured for the moding function selected, refer to Figure 1.67. Consequently the characters displayed may change several times during data entry.

Only the valid alphanumeric characters for data entry at the writer marker position are displayed. A left or right arrow presented on keys indicates there is another available configuration for the data entry keyboard, eg entries requiring alpha characters. Pressing the key displaying a left or right arrow will scroll through the available options.

Up and down arrow keys perform the same function as selecting the toggle switch to the up or down position except in multi-page displays where the are used to select the next/previous page.

Some data inputs are independent of the writer marker position in the ROL. For example; if the N and E options are displayed in the ROL when entering lat/long coordinates, then the keys will give the option to change to S and W options. Selection of such options have no effect on the position of the writer marker but will switch the displayed ROL to the alternative mode.

The '#' can be used to automatically enter leading zeroes into certain data fields. It is selected after the numerical entry and any columns prior to the number are set to zero, eg for a four column field; '5# would enter '0005' and '40#' would enter '0040'.

When entering radio frequencies the last character will be entered automatically dependent on the penultimate number, e.g. if the penultimate number is '0' or '5', a '0' will be entered and if '2' or '7' is the penultimate number, '5' will be entered. The writer marker will always park under the last character of the radio frequency so it can be overwritten if required.

The input data will only be supplied to the subsystem selected if it passes validation after depression of the enter (ENT) key.

Where more than one page of ROL requires data entry for the input sequence, data can only be input to the subsequent page after either, depression of the ENT key, or by paging through the ROL using the toggle switch or the up/down arrow keys.

A 'time check' facility is used to indicate a data entry has been selected and is incomplete. As soon as a data entry option is selected a timer is started. If no key has been selected after approximately 7 seconds, then the ROL data and writer marker will flash twice per second. Any toggle switch, data entry key or X-Y controller selection, with the exception of ENT on the data entry keyboard, will stop the ROL flashing and reset the timer. Depression of the ENT key disables the 'time check' facility.

Enter Key

The input of data has no effect on the selected subsystem until the ENT key is depressed. On selection of the ENT key a validation is performed on the input data. If the data is valid the ROL data, including the writer marker and 'fixed' characters, will occult for between 200 milliseconds and 600 milliseconds. If no further data page entries are required, then the ROL will display the page with the entered data, the writer marker (positioned under the first variable character), and dashes replaced by zeros for partially defined variables.

With the current version of avionics software, multipage ROL configurations only occur for WP details and mode 1 and 3A manual codes associated with the XPDR and INT subsystem.

When a page of data is entered for the mode 1 and 3A manual codes, depression of the ENT key will result in the bracketed mode 1 and 3A code being selected. Movement between pages is possible by using the up/down arrow keys which will be presented when appropriate.

When a page of data is entered for the NAV or SWP subsystem, depression of the ENT key will result in the initial ROL occulting then being displayed again for 900 milliseconds to 1300 milliseconds before the next page requiring data entry is displayed.

When the ROL are displaying the last page of data on a waypoint, depression of the ENT key will result in the first page of the next highest unpaired waypoint being displayed.

Clear Key

The clear key (CLR) enables the quick reconfiguration of the ROL so that an input sequence can be restarted, either for a particular variable or the whole page.

A single depression of the CLR key sets the variable above the writer marker position to dashes and repositions the writer marker under the first column for that variable. Two successive depressions of the CLR key sets all the variables in the ROL to dashes and repositions the writer marker to the start of the first variable. Parameters that are changed independent of the writer marker, eg N, E, S and W variables, are reset to their default values.

Data Validation

There are four types of data validation:

1 The validity of parameters, which when entered cause reconfiguration of other data in the ROL. These immediate validation checks are carried when the last character of the variable has been input. This validation check is performed when entering preset channel numbers in the radio subsystems, and for waypoints in both the SWP and NEW WP options.

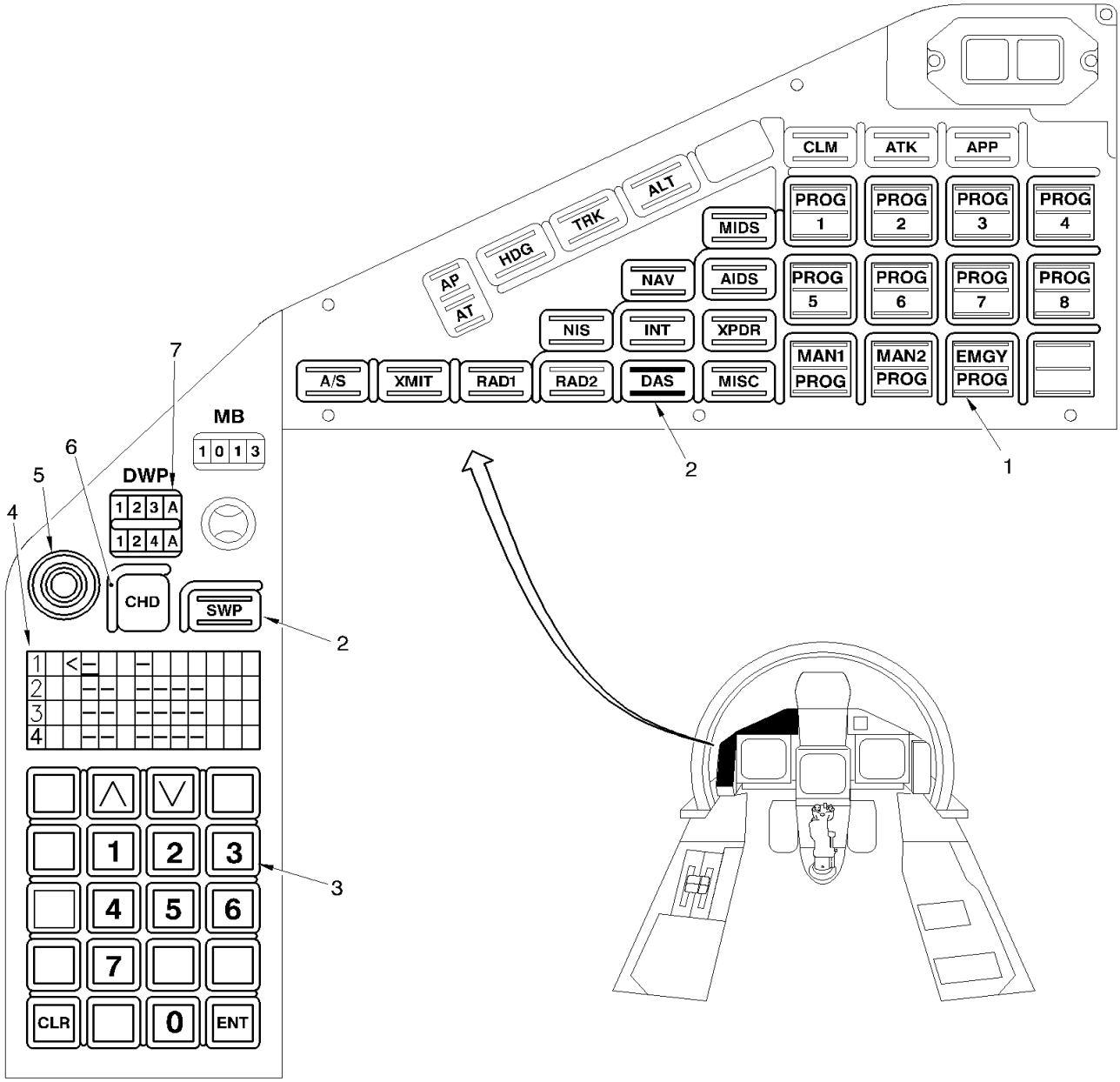
2 On pressing the ENT key all variables are checked that they are within their specified range.
3 Checks to ensure all the required variables have been defined.
4 The final validity check is to ensure the ringback data is the same as that sent, ie the new data sent to the subsystem is returned and compared again with the data sent.
Failure of a validation check is indicated by the variable data and writer marker flashing for 2 to 3 seconds. The writer marker will then be positioned under the first variable that is in error and will continue to flash until the DEK becomes active. Pressing any data entry key will stop the ROL flashing.

Destination Waypoint Read Out Lines

The DWP ROL is a four column by two row display, which indicates the destination waypoint number on the upper row, and the subsequent destination waypoint number on the lower row. ‘HOLD’ will be displayed on the upper row if there is no waypoint selected, and four dashes will be displayed on the lower row if there is no subsequent waypoint.

Change Destination Moding Key

When selected, the change destination (CHD) moding key will make the waypoint shown on the key and the DWP ROL the next DWP. The waypoint numbers on the DWP ROL are automatically updated when CHD is selected.
If the CHD is selected when ‘HOLD’ is displayed on the upper row of the DWP ROL, steering will revert to the previous DWP prior to entering ‘HOLD’.



1 MODING KEYS
2 SUBSYSTEM KEYS
3 DATA ENTRY KEYS
4 READOUT LINES
5 TOGGLE SWITCH
6 CHANGE DESTINATION KEY
7 DESTINATION WAYPOINT READOUT LINES

Figure 1.65 - MDEF - Controls and Indicators

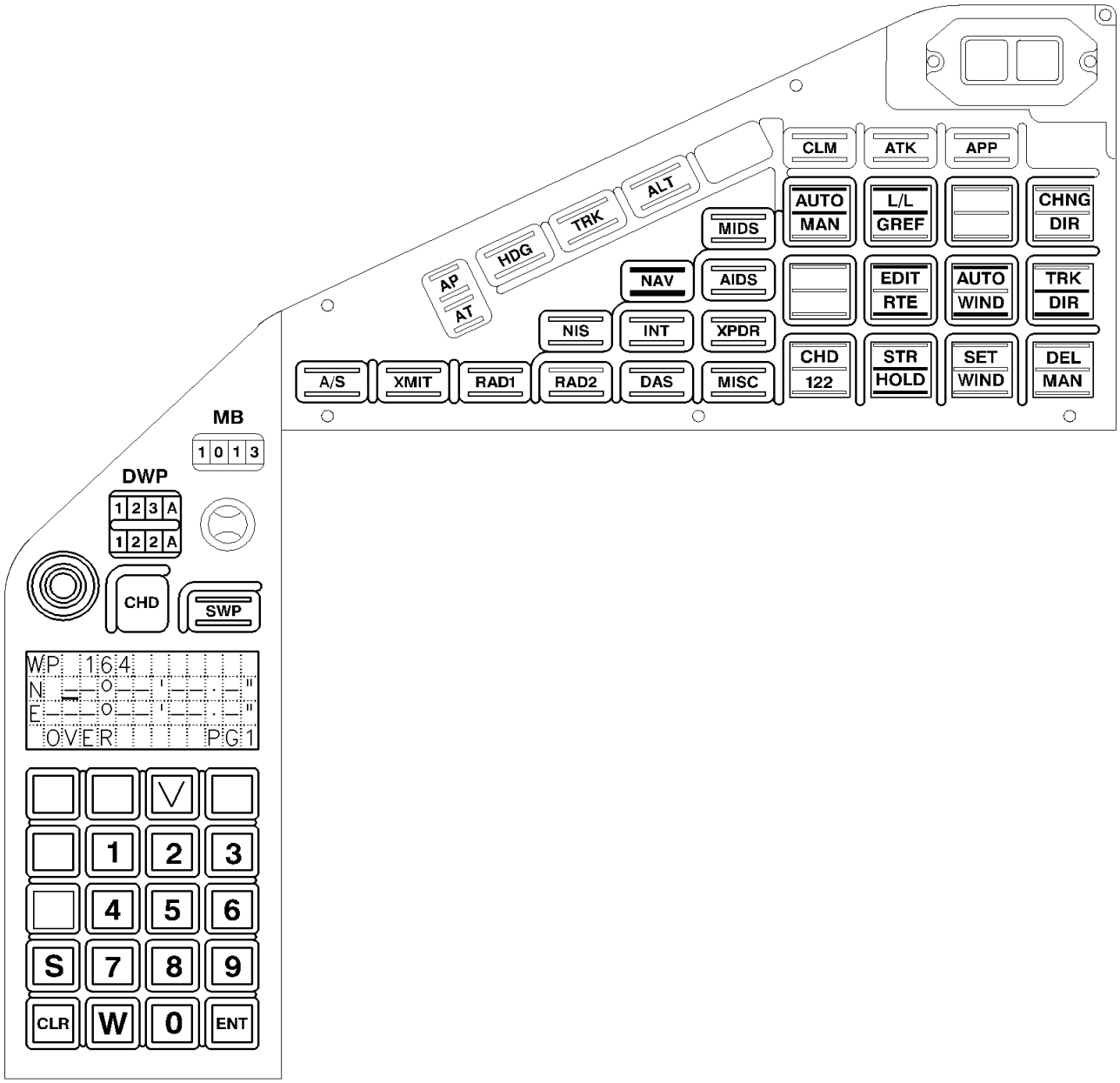


Figure 1.66 - Moding Key Configuration - Navigation Subsystem (Default Moding Weight-off-Wheels)

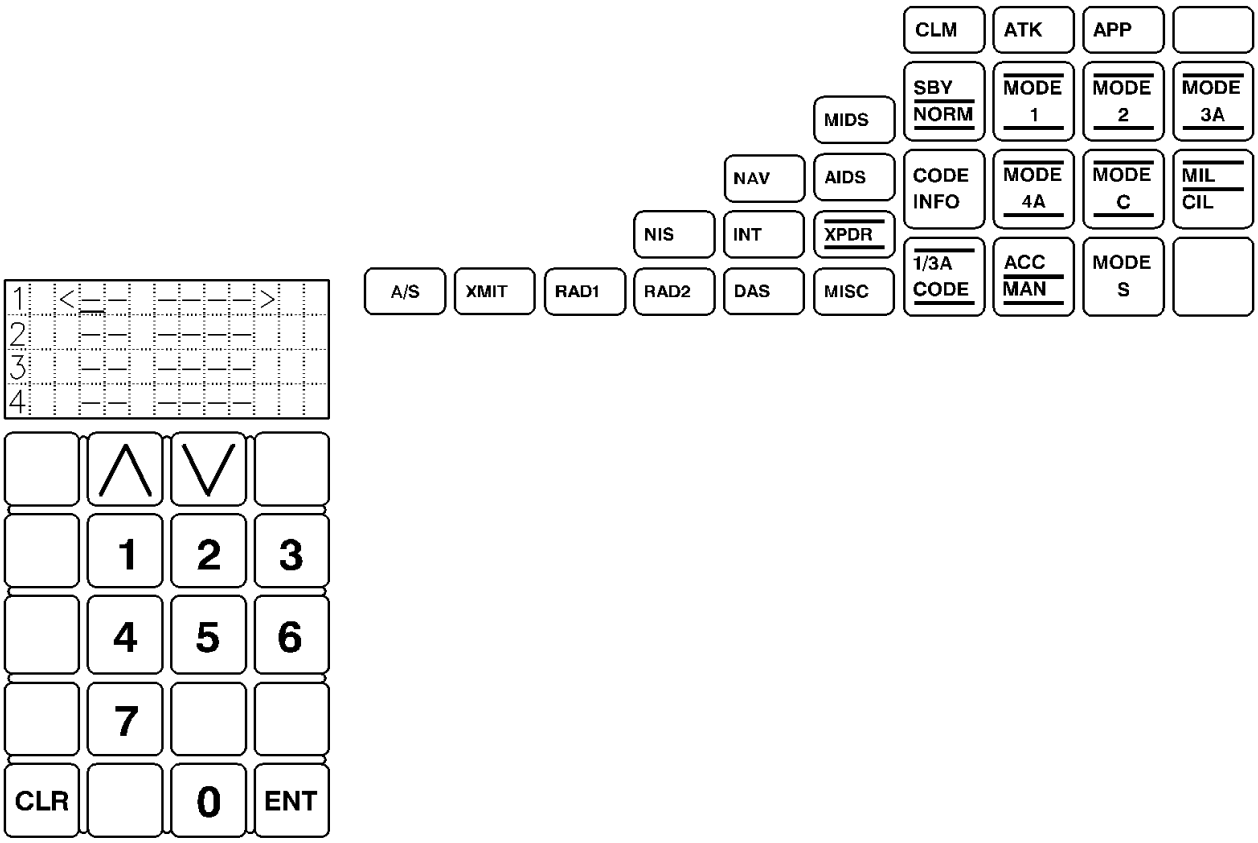


Figure 1.67 - Data Entry Key Configuration - Transponder Subsystem

Miscellaneous MDE

(1B-B-31-11-00-00A-111B-A Issue 002)

Introduction

Pressing the MISC subsystem key on the left glareshield enables the selection of the following functions:

– Stopwatch
– Bogus weapon configuration
– Lamps test
– Bingo fuel settings
– Automatic cryptovariable suppression
– Video Voice Recorder (VVR) status
– Simulated target generation
– Ground proximity warning

Operation

On initial selection of the MISC subsystem key the display stopwatch (DISP WTCH), ground proximity warning system (GPWS), count up (CNTU) and bogus AMRAAM (BGUS AMR) moding keys are selected as the default options, refer to Figure 1.68 . If, on initial selection the stopwatch is active and in CNTU mode, then the display would change to count down (CNTD). The ROL, HUD and MHDD/HDHUD format display stopwatch time, set to zero, and only CLR and ENT are displayed on the keyboard.

NOTE

- With the current software version there is no ROL or data entry keyboard moding associated with the BGUS AMR option; it will only be displayed if:
  - THE FUNCTION HAS BEEN LOADED VIA THE MAINTENANCE DATA PANEL (MDP)
  - NO LIVE WEAPONS WERE FITTED (MISSILES AND/OR GUN) AT THE START OF THE MISSION.
- The BGUS AMR simulates the selection of an AMRAAM and the subsystem behaves as if the aircraft is armed, refer to Surveillance/Attack and Identification pag. 1-471.

Stopwatch/Count Up

The stopwatch is started on the default display by pressing the STRT TIME key. Upon pressing this key the ROL, HUD and HDHUD will display the elapsed time (Figure 1.69), all the data entry keys are disabled and the moding keys reconfigure to give the STOP TIME and split time (SPLT TIME) options (Figure 1.70). On selection the split time is displayed below the stopwatch time on the ROL, HUD and HDHUD.

When STOP TIME is selected, the moding keys reconfigure to display the STRT TIME and timer reset (RSET TIME). The RSET TIME key occults after selection.

The stopwatch ROL display will occult if either MISC or DISP WTCH is deselected, however, it will be displayed on the HUD and HDHUD when the stopwatch is active (running/split). Reselection of the subsystem or stopwatch will display the current stopwatch time.

Stopwatch/Countdown

The countdown function is selected by pressing the CNTU CNTD moding key. Countdown selection is indicated by the illumination of status bars on the CNTD key legend. On initial selection the ROL displays dashes where data entry is required, and the data entry keyboard is configured for numerical entry (Figure 1.71). The data entry CLR key will set the data entry field to dashes if a countdown time has previously been entered.

All leading zeroes must be entered and when inputting the data, the ROL will blink and the moding keys reconfigure to display STRT TIME.

On pressing STRT TIME countdown will commence in the ROL, HUD and HDHUD, the moding keys will reconfigure to display the SPLT TIME and STOP TIME options. Also, the data entry keys will occult, with the ENT and CLR keys disabled. The SPLT and STOP TIME options operate in the same way as that for the count up stopwatch selection.

Upon reaching zero, the ROL reconfigures to the initial countdown time set and STRT TIME is redisplayed on the moding keys. The countdown indication (00:00:00) on the HUD and HDHUD will flash for 5 seconds, after which it will be occulted unless the MISC DISP WTCH submode is selected or the stopwatch becomes active.

Lamps Test

The lamps test function is for ground maintenance purposes. All the available lamps test options will be displayed on LAMP TEST selection with weight on wheels and NH less than or equal to 70% (Figure 1.72). The only test option available with weight off wheels is a bulb test. The BULB TEST moding key has to be pressed to select this option. The test will illuminate all the dedicated indicators with the exception of the FCS indicators, the backlighting of controls and the cockpit floodlights. The attention getters will also flash during the test. On completion of the test press the BULB TEST moding key again.

Bingo Fuel Settings

Four bingo fuel levels can be specified or modified by selecting the FUEL BNGO moding key. On selection, the ROL displays the current bingo fuel settings and data entry keyboard configures for numerical entry (Figure 1.73).
On initial selection the ROL display dashes where data entry is required, and the last digit of the fuel levels are fixed at zero. Fuel levels can be specified to an accuracy of 10kg but they must not be within 100kg of each other; BINGO 4 cannot be set to less than 200kg. The CLR key will set ROL 4 to −200kg when pressed.
A voice warning is given when a bingo level is reached and the particular data entry occults from the ROL if FUEL BNGO is still selected.
The writer marker will be positioned under the first digit of the lower bingo fuel setting if two entries are within the minimum 100kg separation.

CAUTION

ENSURE DATA ENTRIES ARE ACCURATE; THERE IS NO VALIDATION CHECK CARRIED OUT BETWEEN BINGO ENTRIES AND ACTUAL FUEL CONTENTS ON PRESSING ENT.

All four data entry fields must be completed before the data is entered. The ROL will blink upon pressing the ENT key, then redisplay the data. If the data entry fails validation, the writer marker will be positioned under the first character of the field in error.

Automatic Cryptovariable Suppression

Cryptovariable codes are necessary for operation of the ECCM modes and for secure speech encryption and decryption. The key of day (KOD) cryptovariables are used for voice encryption and decryption functions. The word of day (WOD) cryptovariables are used for ECCM functions.
On application of power, the system will default to the unsuppressed setting.
The CRYP SUPP moding key is used to suppress cryptovariable voice warnings, DWP warnings and the autocue format warning captions whilst on the ground, and is confirmed by the illumination of status bars on the moding key legend.
The suppression of cryptovariable warnings is automatically removed if any of the cryptovariables are loaded on application of power to the system, or if any of the following warnings occur:

– RAD1 (WOD) or (KOD) warning
– RAD2 (WOD) or (KOD) warning
– IFF-Transponder crypto alarm
– IFF-Interrogator crypto alarm.

NOTE

There is only a single crypto alarm for both the IFF interrogator and the IFF transponder.

Video Voice Recorder Status

Selection of the VVR key displays the current state of the VVR on the key legend, and the elapsed record time in the ROL, refer to Figure 1.74 .
The key legend can show four possible modes:

– VVR OFF
– VVR SBY (displayed when a cassette is installed and PBIT has successfully completed)
– VVR REC (displayed when in either auto or manual record)
– VVR FAIL (displayed when the unit has failed PBIT, CBIT or IBIT).

The default mode of the VVR is standby (SBY), in this mode the VVR is automatically controlled by the avionics system. When the aircraft has weight off wheels, the VVR will automatically enter the record (REC) mode when any of the following conditions exist:

– Entering the combat POF
– The late arm switch is selected
– The trigger first detent is engaged
– A VISIDENT target is less than 1NM.

In automatic control, the VVR will stop recording and enter SBY mode 15 seconds after any of the conditions listed above no longer exist. However, if another of the conditions listed above is initiated during this time, then the VVR will continue to record, and only enter STBY 15 seconds after the subsequent condition has been completed or exited.

Simulated Target Generation

Upon selection of the SIM TGT key, the subsystem generates a simulated target with a default speed, range, bearing and altitude, refer to Surveillance/ Attack and Identification Subsystem pag. 1-457.

Ground Proximity Warning System

The GPWS is an integrated terrain/obstacle avoidance system that is based on a terrain/map reference navigation capability. The MDEF is used to switch the GPWS between ON and OFF and to display the minimum separation distance (MSD) height. Refer to Ground Proximity Warning System pag. 1-117.

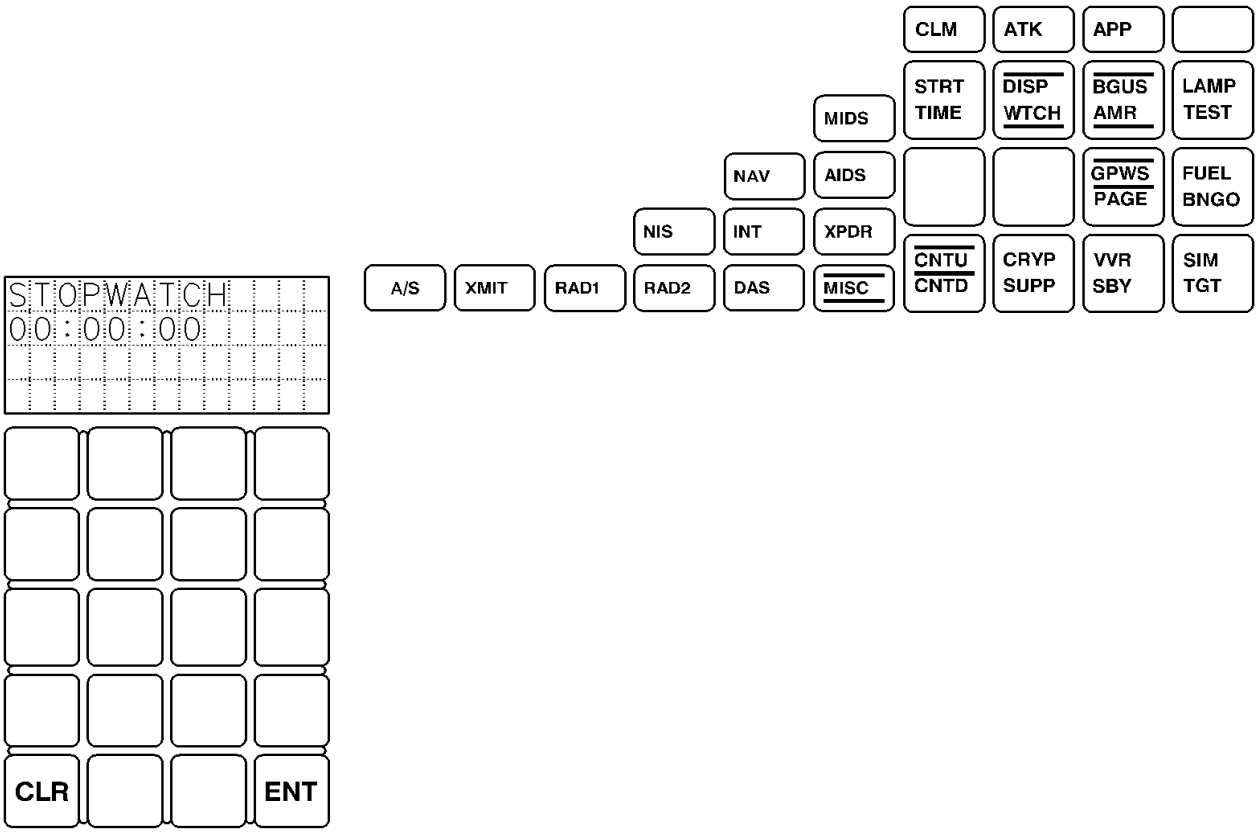
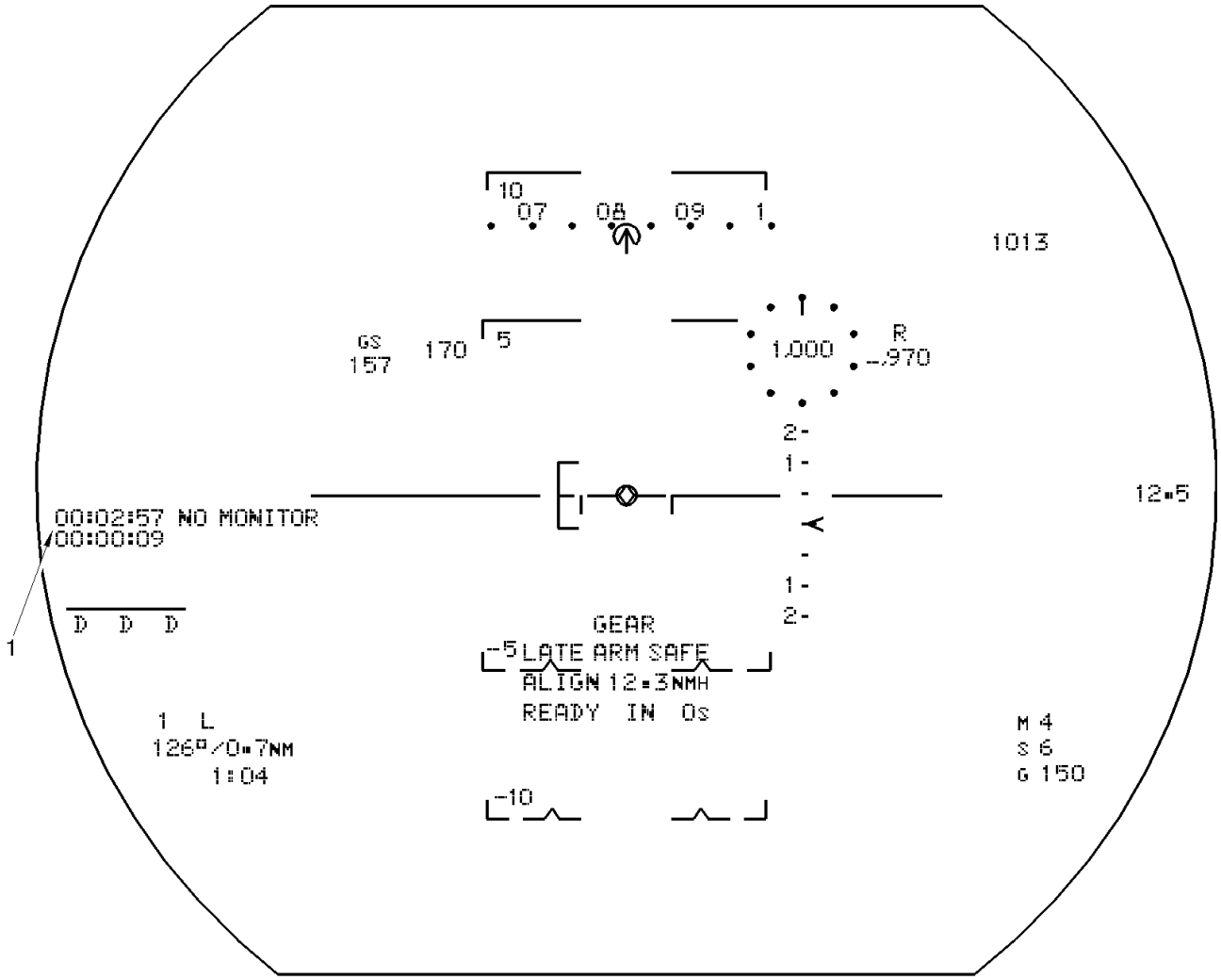


Figure 1.68 - Miscellaneous Subsystem Default Configuration



1 STOPWATCH

Figure 1.69 - HUD - Stopwatch Symbology

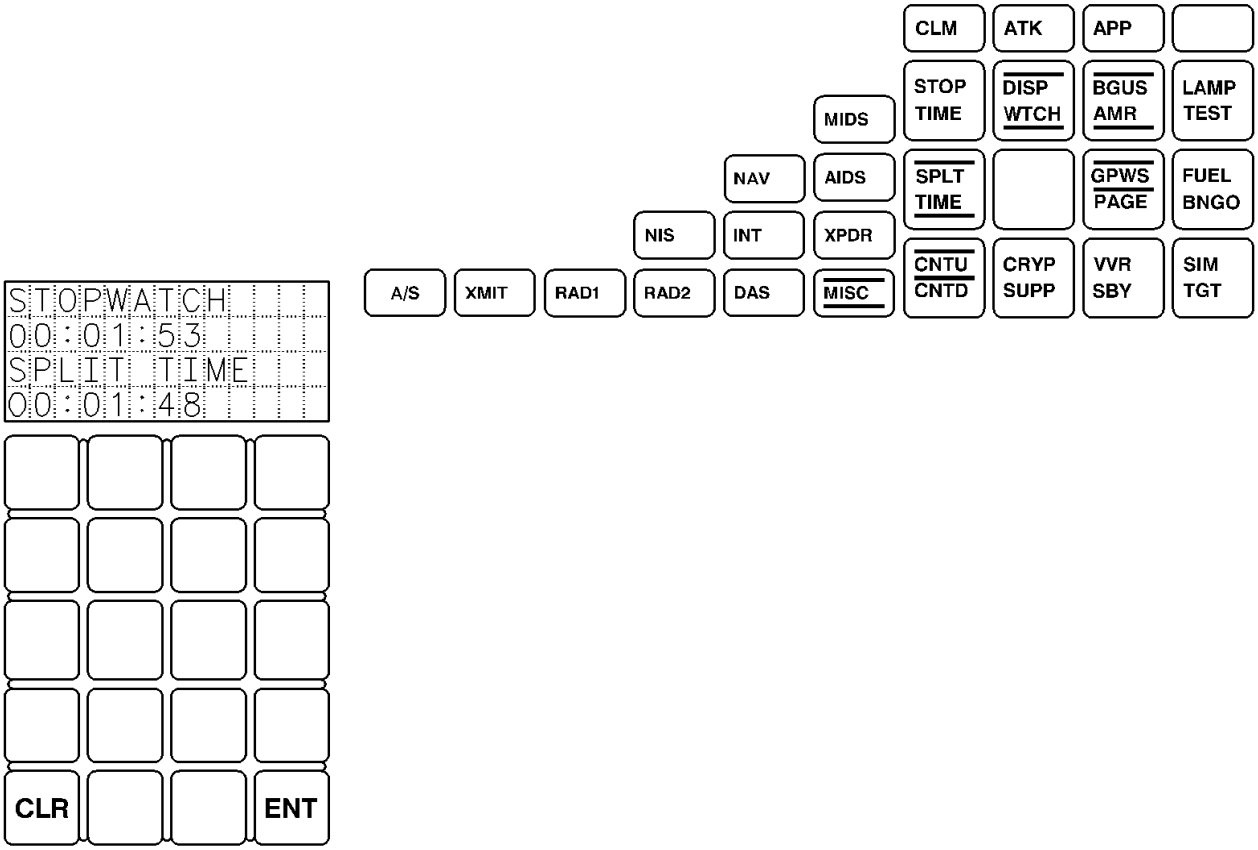


Figure 1.70 - Stopwatch Count Up Configuration - Active

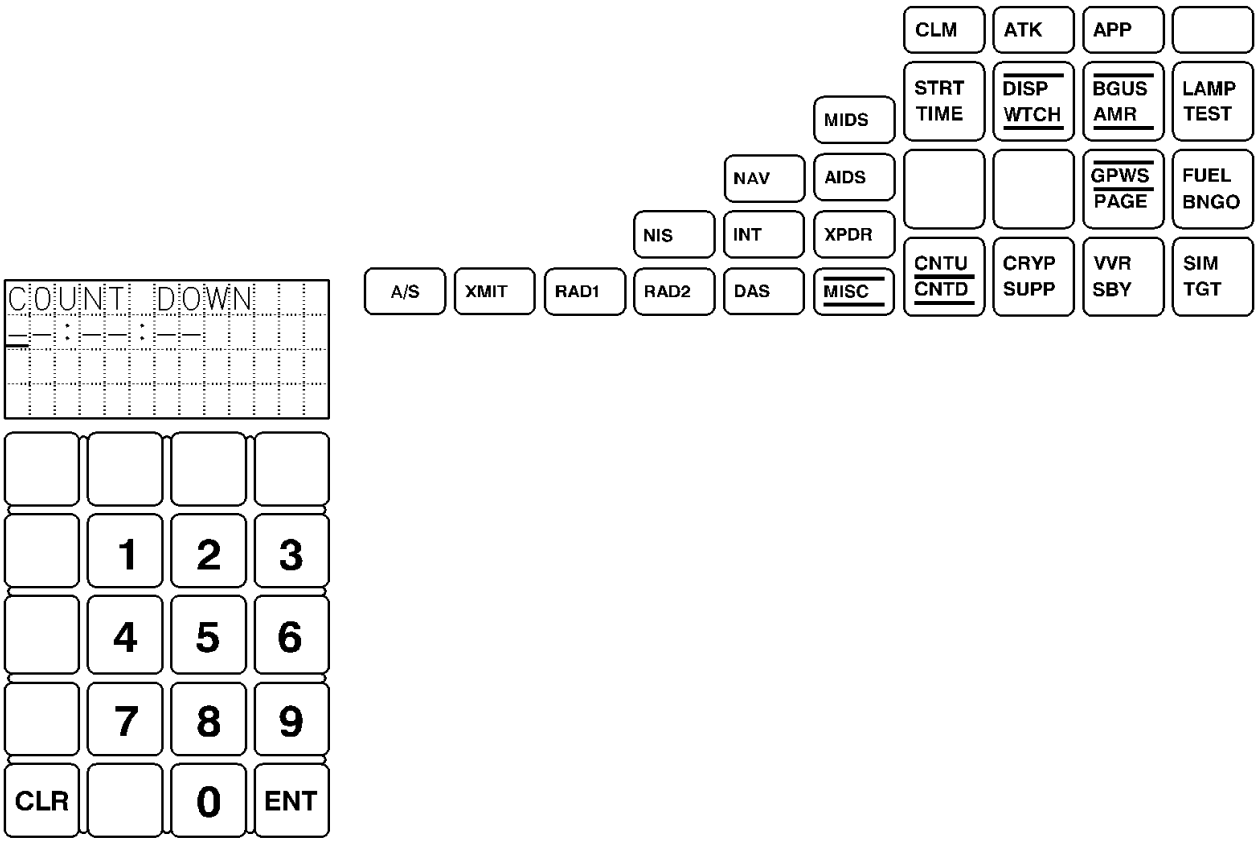


Figure 1.71 - Stopwatch Countdown Initial Configuration

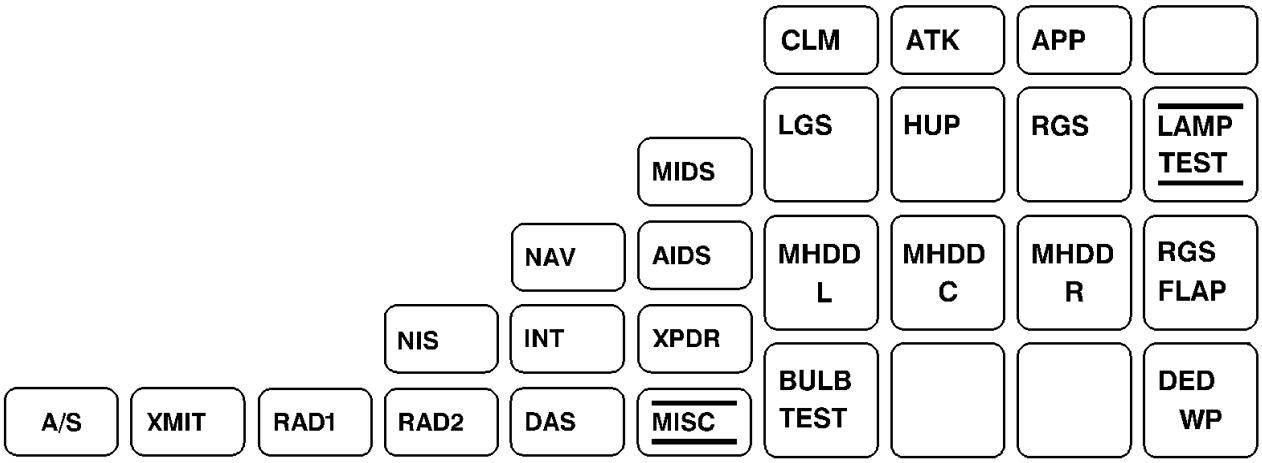


Figure 1.72 - Lamps Test Options - Weight on Wheels

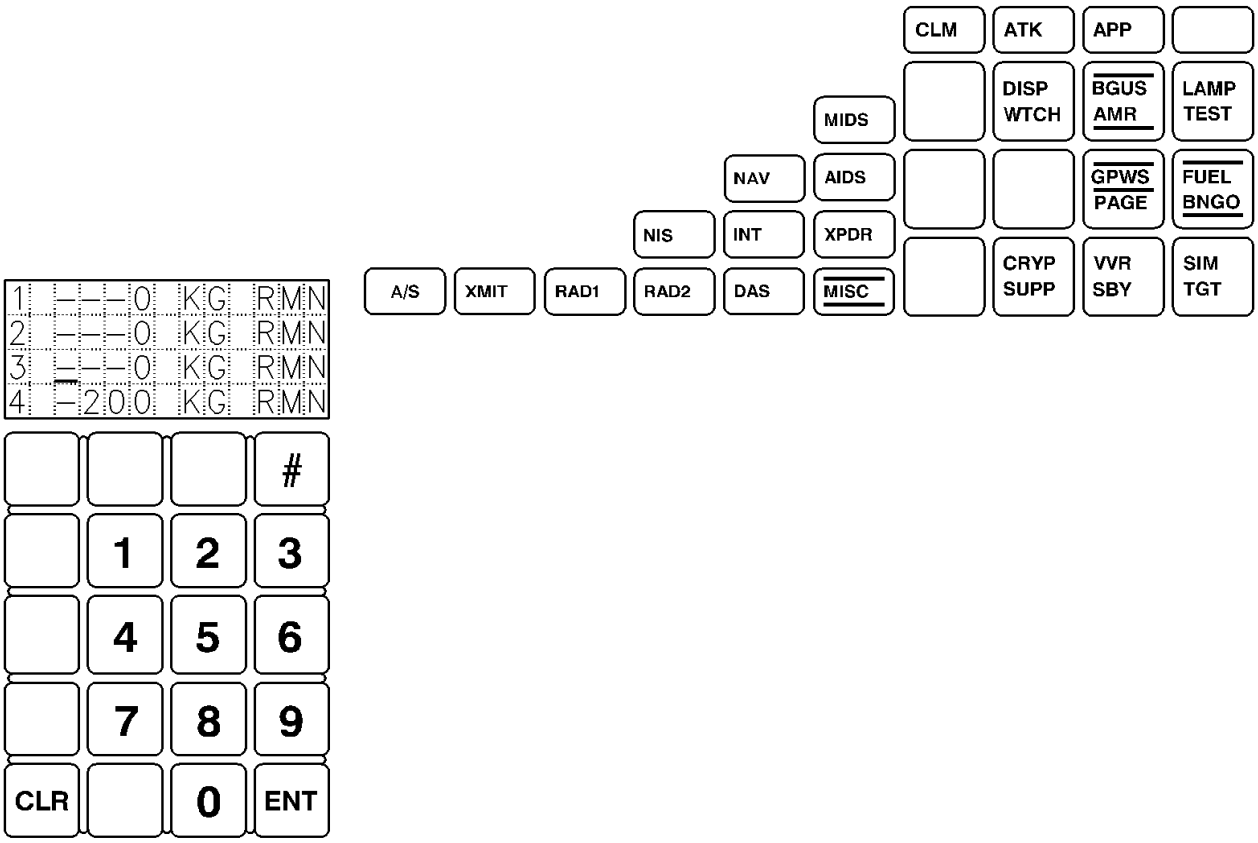


Figure 1.73 - Bingo Fuel ROL

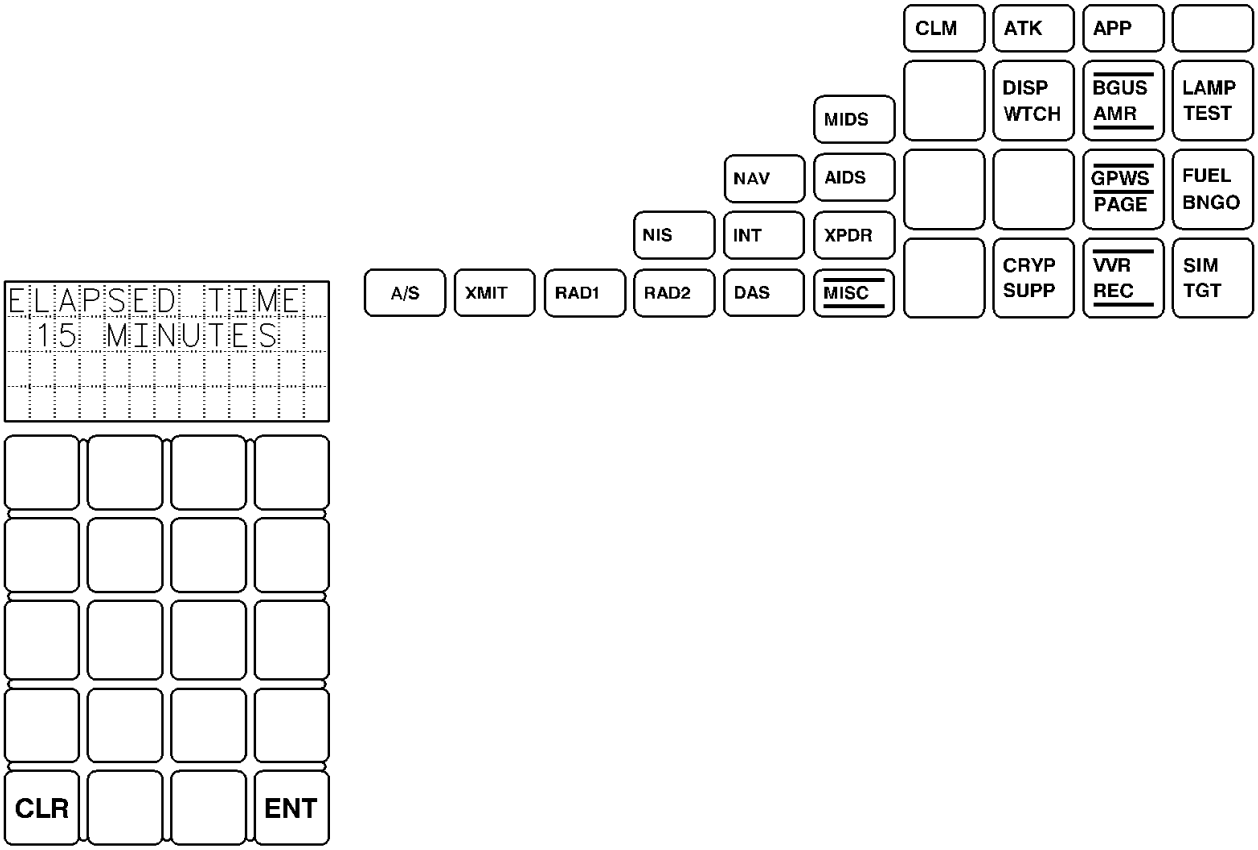


Figure 1.74 - Video Voice Recorder ROL

Hands on Throttle and Stick

(1B-B-31-10-01-00A-111A-A Issue 003)

Introduction

The throttle and stick tops contain a number of controls to allow weapon system moding and sensor control, providing a HOTAS facility. Different submodes can be selected as a result of the duration of button depression, ie, <1 second (short press) or >1 second (long press).

Throttle Top Controls

The throttle top contains eight selectable HOTAS controls:

Outboard Throttle Top (Figure 1.75):

– SRAAM reject
– Chaff/flare release
– Lights Kill
– Radar elevation control and A/S gain.

Inboard Throttle Top (Figure 1.76):

– Communication control (DVI not yet available)
– X-Y controller
– Target list rotate, re-attack
– Autothrottle switch
– Airbrake selector.

SRAAM Reject

When SRAAM is selected the operation of this button will reject the current SRAAM selection. Further selection will reject the next available SRAAM, and so on. When the last available SRAAM has been rejected subsequent operation will reset SRAAM selection.

NOTE

SRAAM selection feedback is available through the HUD, HDHUD format, Attack format and PA formats.

Chaff/Flare Release

Movement of the switch to the forward/aft position will initiate the dispensing of the chaff/chaff and flares package respectively. Forward movement of the switch is the default chaff only position, unless another function is selected on the MDEF. Aft movement of the switch is the chaff and flare default position.

Lights Kill

A long press of the switch controls the on/off function of the cockpit lighting. Further operation of the switch will toggle the lighting on or off. The following lighting is controlled by the lights kill switch:

– Forward and rear floodlights
– Console electroluminescent (EL) panels
– Console and pedestal panel indicators
– Equipment panel legends.
– Warnings and attention getters

Both cockpits have independent lighting controllers. However, if the aircraft is configured to solo mode and the lighting system is set to normal, control of the rear cockpit lighting is from the lights kill switch in the front cockpit.
For additional information, refer to Lighting System pag. 1-322.

Radar Elevation Control and Radar A/S Gain

This control will adjust the radar elevation and radar A/S gain. For additional information, refer to Radar pag. 1-482.

Communication Control

Movement of this control to the upward position will select the combined VWS/communications mute function. Momentary movement to this position will cause VWS (Voice Warning Suspend) to be selected for 15 seconds. When the control is moved to the upward position and held, VWS and communications mute are selected for the duration of the press. Upon release communications mute is deselected but voice warnings remain suspended for a further 15 seconds.
When the control is moved to the forward position and held, transmissions via radio 1 are initiated. When it is moved to the aft position and held, transmissions via radio 2 are initiated. When it is depressed and held, transmissions via radio 1 and radio 2 are initiated simultaneously. For additional information, refer to V/UHF Radio pag. 1-396.

X-Y Controller

Omni-directional movement of this control will move the X-Y marker in the corresponding direction on either the HUD or the MHDD display. This action can also be used to slew the sensors. A short press of the control will initiate the X-Y insert function.

Designated Target List Rotate and Re-attack

A short press of this button will cycle through the Designated Target List (DTL), moving the first item to the last position. Along press will select re-attack.

Autothrottle Switch

Movement of this switch to the forward/aft position will increase/decrease the speed acquire datum, respectively (shown on the HUD). A short press to

the downward position will engage/disengage the autothrottle speed acquire function. A long press will enable the aircrew to toggle between the speed acquire indications, ie, CAS and Mach Number.

Airbrake Selector

Movement of this switch to the forward/aft position will retract/extend the airbrake, respectively.

Stick Top

The stick top contains nine selectable HOTAS controls (Figure 1.77):

- A/A weapon selector
- Radar air combat mode, radar lock/break lock
- Late Arm Selector
- Pitch and roll trim control/autopilot heading and attitude datum adjust
- IFF Interrogate
- ICO/NWS disconnect switch
- Autopilot engage/disengage button
- A/A missile/gun trigger (record)
- Weapon Release Button

Air to Air Weapon Selector

The movement of the A/A weapon selector to the forward position will select MRAAM. The system will then choose one of the following modes:

- Normal
- Radar Home on Jam (RHOJ)
- Visual.

Further movements of the A/A weapon selector to the forward position enable the aircrew to toggle between the system choice and visual mode (if visual mode is not already selected).

Movement of the A/A weapon selector to the aft position will select the A/A gun in ‘director gun sight’ providing there are rounds available to fire. Mixed mode is the default aiming display if the radar is in lock follow mode, otherwise only secondary mode will be available.

Depressing the A/A weapon selector will select SRAAM in slaved mode. Further presses will enable the aircrew to toggle between manual and slaved modes. If SRAAM has been selected, movement of the control to the right will cage/re-cage the SRAAM.

Movement of the A/A weapon selector to the left will select the priority target accept function. For additional information, refer to Weapon Aiming/ Release System pag. 1-599.

Radar Air Combat Mode, Radar Lock/Break Lock

Movement of this control to the forward position will select the combined slave/Boresight Acquisition Mode (BAM). When radar lock is achieved in this mode, reselection will cause the rejection of the track lock.

Movement of the control to the aft position will select the vertical scan acquisition (VACQ) mode. When radar lock is achieved in this mode, reselection will cause the rejection of the track lock.

Movement of the control to the right will select HUD acquisition (HUDQ) mode. When radar lock is achieved in this mode, reselection will cause the rejection of the track lock.

Depressing the control will select the radar lock/ break lock function, depending on the current radar status:

- With radar lock achieved, break lock will be initiated
- If air combat mode is selected, it will be cancelled, causing the radar to return to the previously selected A/A mode
- With the radar in search mode it will lock. This is used in conjunction with the X-Y function.

For additional information, refer to Radar pag. 1-483.

Late Arm Safety Interlock

Movement of this switch to the forward position will deselect the safety arm interlock (OFF), exposing an orange marker. Movement to the aft position will select the safety arm interlock (ON).

NOTE

The weapon release interlock is located on the side console and is not a HOTAS control.

When the rear cockpit interlock is OFF, the front interlock and weapon release functions will operate normally. When the rear cockpit interlock is ON, the front cockpit interlock and weapon release functions are inhibited, ie, the rear cockpit has command.

Pitch and Roll Trim Control/Autopilot Heading and Altitude Datum Adjust

Movement of this control to the left/right will increment the current roll trim demand to port/ starboard, respectively. Movement to the forward/aft position will increment the current pitch trim demand to dive/climb, respectively.

If the autopilot or an autopilot mode is selected then the switch is remoded; movement left/right will cause the heading datum, displayed on the HUD, to change in an anticlockwise/clockwise direction, respectively. Movement to the forward/aft position will reduce/ increase the altitude datum, respectively.

IFF Interrogate

Depressing this button will initiate the IFF Interrogation mode. For additional information, refer to Identification System pag. 1-539.

ICO/NWS Disconnect

In a WOW condition, pressing this button will disengage NWS, provided NWS is already engaged. With weight off wheels pressing the button will disengage the autopilot and autothrottle functions (ICO).

Autopilot Engage/Disengage Button

Depressing this button will engage/disengage the autopilot, depending on the current mode.

Air to Air Missile/Gun Trigger (Record Only)

NOTE

HUD recording will dominate for SRAAM and GUN selections. MHDD/ Attack format will dominate for MRAAM selection.

Pulling the trigger to the first detent, regardless of the late arm setting, will select the record mode. For additional information, refer to Head up Display pag. 1-34. With the late arm set to LIVE the second detent may be selected, which will initiate the release/launch/firing sequence, providing the following criteria are met:

– A weapon is currently selected
– MASS is set to LIVE
– Weight off wheels
– Late arm is selected to LIVE.

On initiation of display recording, by depressing the trigger, the sampling rate for each display will be commanded depending on the weapon type selected.

Weapon Release Switch

Operation of this switch will release the selected store from the aircraft, assuming that other conditions and selections are selected correctly. The weapon release switch is guarded by a hinged flap to prevent inadvertent operation.

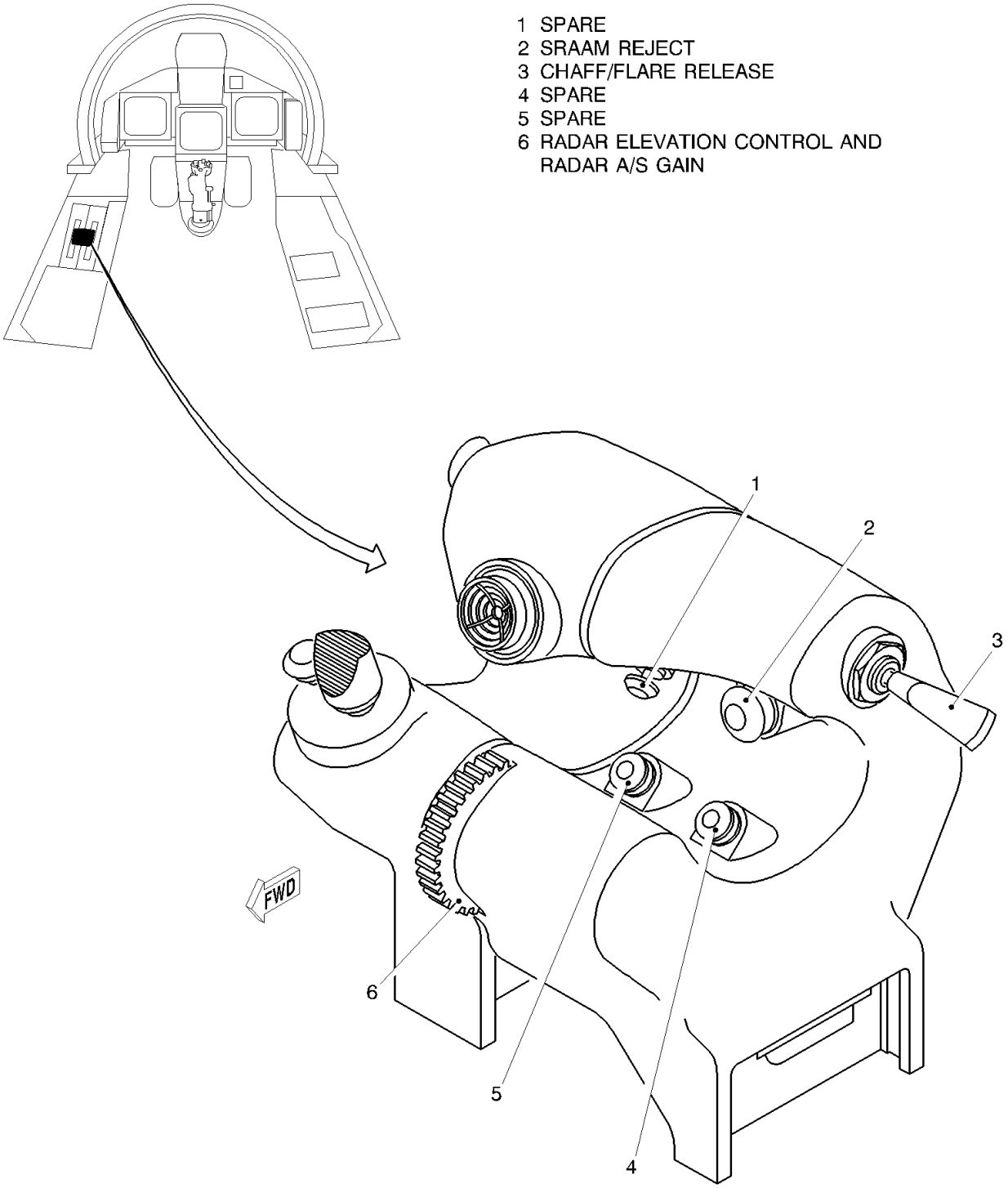


Figure 1.75 - Left Throttle Top

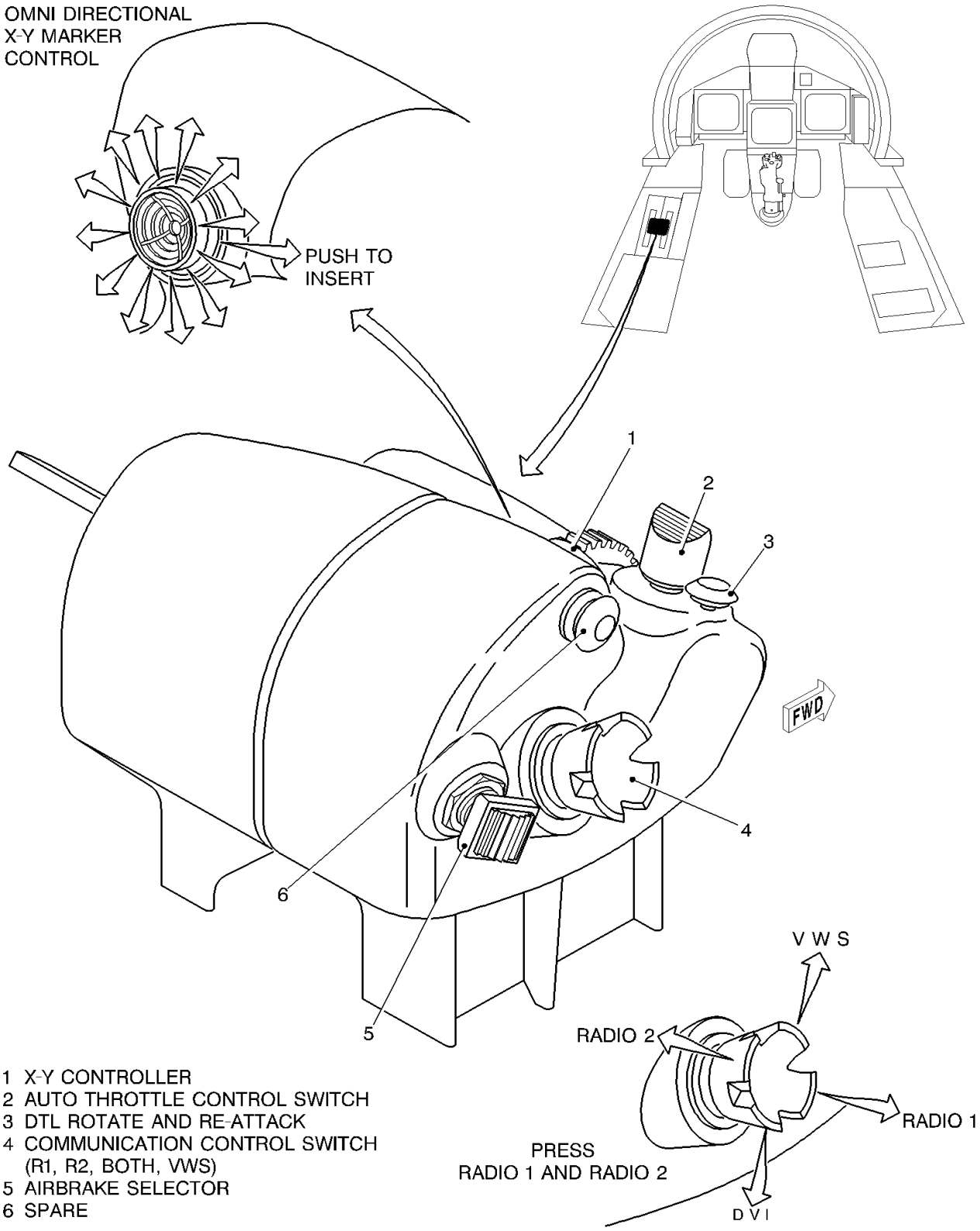


Figure 1.76 - Right Throttle Top

1 AIR-TO-AIR WEAPON SELECTOR
2 RADIO 1 PTT
3 RADAR AIR COMBAT MODE, RADAR LOCK/BREAK LOCK
4 LATE ARM SAFETY INTERLOCK/WEAPON RELEASE INHIBIT
5 WEAPON RELEASE
6 PITCH AND ROLL TRIM CONTROL/AUTOPILOT HEADING AND ALTITUDE DATUM ADJUST
7 IFF INTERROGATE
8 ICO/NWS DISCONNECT SWITCH
9 AUTOPILOT ENGAGE/DISENGAGE BUTTON
10 AIR-TO-AIR MISSILE/GUN TRIGGER, HUD RECORD ONLY

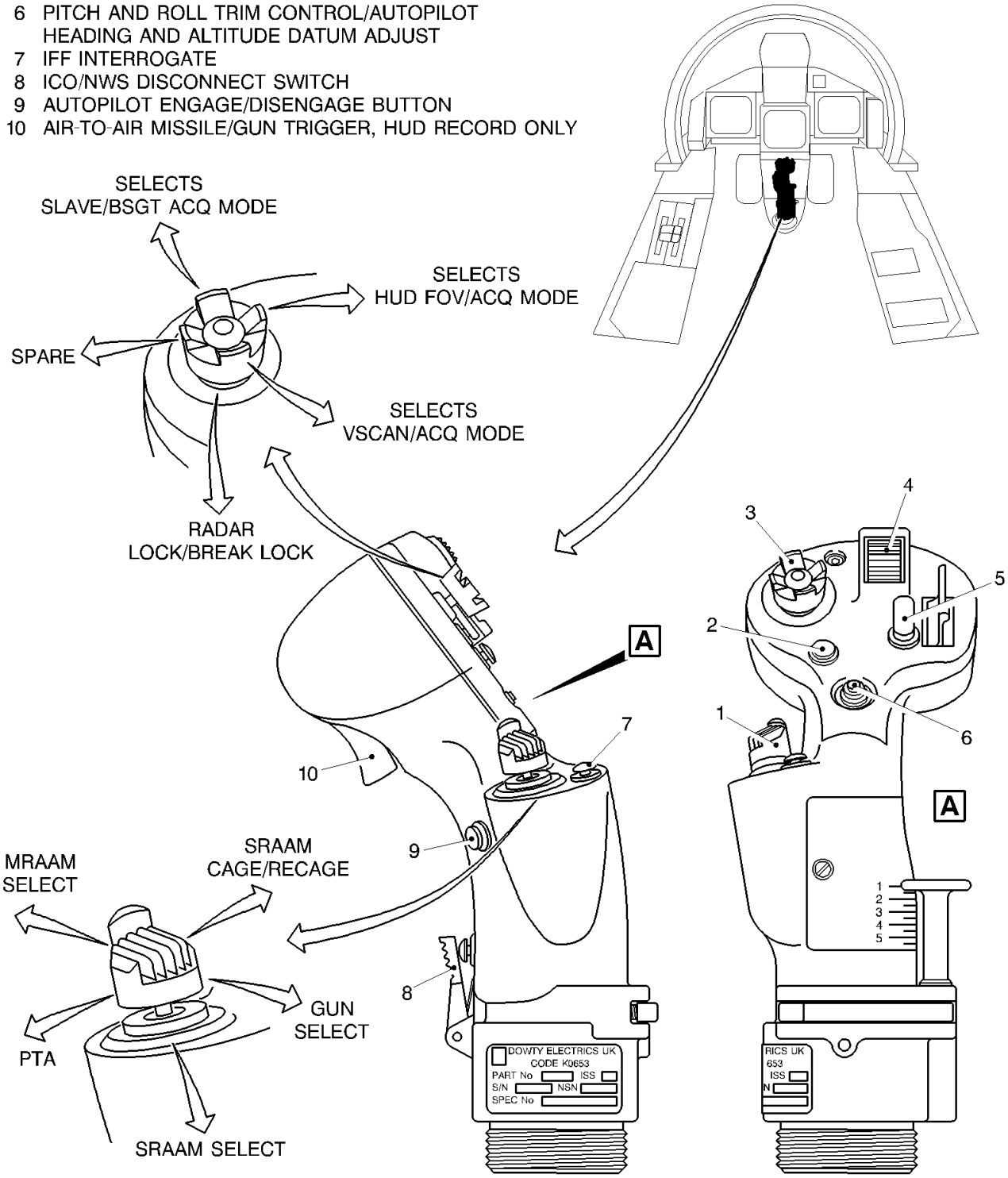


Figure 1.77 - Stick Top

Get-U-Home Instruments

(1B-B-31-20-00-00A-043A-A Issue 002)

Introduction

In the event of a failure resulting in the loss of the main front and rear cockpit displays, a number of reversionary GUH instruments, located on the HUD Control Panel (HUDCP), Figure 1.78, and the right glareshield, Figure 1.79, provide the necessary flight information to assist the pilot in a safe return to base. The Dedicated Warnings Panel (DWP) can also revert to a reversionary layout enabling a number of hardwired warnings only to be displayed. The GUH instruments in the rear cockpit are identical to those in the front cockpit. For additional information, refer to Get-U-Home Warnings pag. 1-446.
Under GUH conditions, the reversionary altitude indicator is adjusted using the normal barostatic pressure setting control, situated on the left glareshield.
GUH instruments are as follows:

- Fuel contents displays
- Engine speed indicators
- Reversionary attitude indicator
- Reversionary heading indicator
- Slip indicator
- Reversionary angle of attack indicator
- Emergency airfield track indicator
- Emergency airfield designator code display
- Emergency airfield range display.

During normal aircraft operation, a vertical row of GUH instruments on the right glareshield is covered by the Dedicated Readout Panel (DRP). The panel, which is spring-loaded and hinged on the outboard edge of the right glareshield, may be manually released to reveal the GUH instruments listed below:

- Reversionary Mach number display
- Reversionary airspeed indicator
- Reversionary vertical speed indicator
- Reversionary altitude indicator.

Fuel Contents Displays

The fuel contents displays comprise three digital readouts, each four digits in length. The readout lines are marked FWD, REAR and TOTAL and represent the amount of fuel remaining in the forward tank group, in the rear tank group, and the total fuel content respectively.

Engine Speed Indicators

The engine speed indicators are located at the lower left and right of the HUDCP and consist of two nonlinear curved gauges, each with a digital readout in the center. The gauge provides an analog reading of engine speed whilst the readout line provides a digital reading. Each gauge represents zero to 105%.

Reversionary Attitude Indicator

The attitude of the aircraft is displayed on a 76mm Active Matrix Liquid Crystal Display (AMLCD) indicator, which is divided into two sectors. The sectors, colored blue and brown, indicate pitch attitudes above and below the horizon. The aircraft is represented by a symbol fixed at the center of the instrument. Pitch angles to ±90° are marked in increments of 5° with each 10° mark numbered, i.e. 10°, 20°, 30°, 40° etc. Above the +85° mark there is a Zenith Star and below the −85° mark is a Nadir Star. A conventional slip indicator is incorporated immediately below the instrument. The pointer on these symbols points to the nearest horizon.

Reversionary Heading Indicator

The reversionary heading indicator provides an indication of aircraft true heading to an accuracy of 1° over a 360° range. The instrument comprises a rotating compass card, read against a fixed pointer at the top of the instrument. The display is marked in steps of 10° with multiples of 30° numbered.

Slip Indicator

The slip angle is read by the position of a solid circle (or ball) against a non-linear slip scale, with zero slip angle being in the middle of the scale. Each scale mark represents 3°; and maximum deflection represents a slip angle ≥10°.

Reversionary Angle of Attack Indicator

The aircraft AOA is displayed on a bar type indicator, against a fixed vertical scale. The datum of the bar indicator is fixed at the zero degree position and increases in length upwards or downwards from this point to indicate positive or negative AOA. The range of the instrument is -15° to +40°, marked in 5° steps.

Emergency Airfield Track Indicator

Emergency airfield track angle error is displayed on the periphery of the compass rose, via a triangular pointer which moves around the outside of the heading scale. Upon failure of the information source, the triangular pointer changes color from green to red and the last good track error remains indicated.

Emergency Airfield Designator Code Display

This display indicates the designator code of a emergency airfield. The display is located in the lower left of the reversionary instrument and comprises a four character length line readout, surrounded by a green colored box. Upon failure of the information source, the last good data remains displayed but the box color changes from green to red.

Emergency Airfield Range Display

This display indicates the range to an emergency airfield with an accuracy of ±0.1 nautical miles. A decimal point will appear after the third digit of the display. The display is located in the lower right of the reversionary instrument and comprises a four character length line readout, surrounded by a green colored box. Upon failure of the information source, the last good data remains displayed but the box color changes from green to red.

Reversionary Mach Number Display

This three digit readout, situated above the airspeed indicator, indicates Mach number (M) to a resolution of M 0.01.

Reversionary Airspeed Indicator

Airspeed is indicated by a pointer on a circular scale. In the center of the display is a digital readout with a rolling last digit, which also indicates the airspeed (to a resolution of 1kt). The resolution of the analog display is:

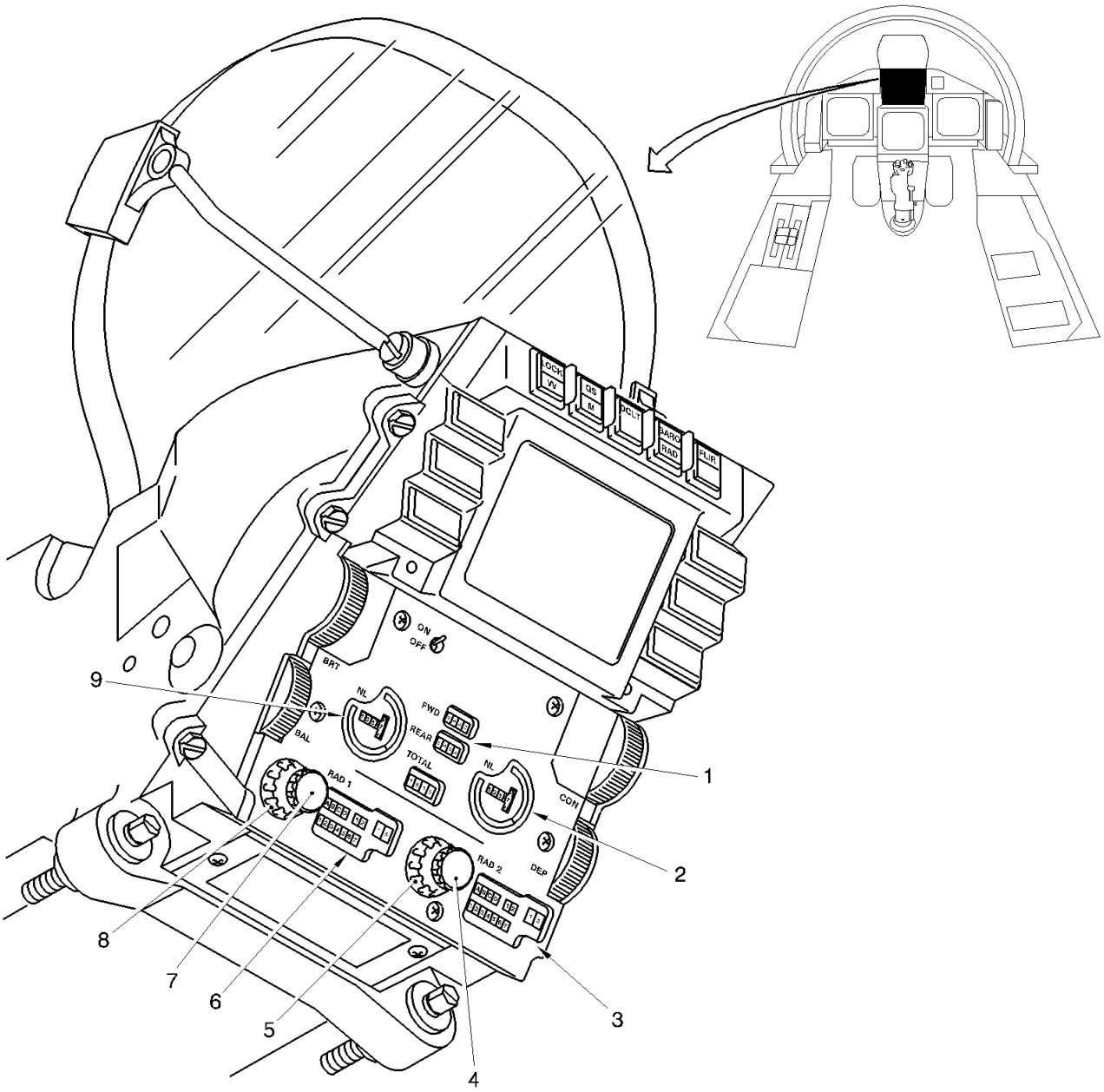
– 50 to 300kt (display resolution; 5kt)
– 300 to 400kt (display resolution; 10kt)
– 400 to 850kt (display resolution; 16kt).

Reversionary Vertical Speed Indicator

Aircraft vertical speed is indicated by a pointer on a circular scale. The scale is marked in steps of 100ft/min up to 1000ft/min and in 500ft/min steps between 1000 and 6000ft/min. Rate of climb/dive is indicated by a pointer above/below the zero datum respectively.

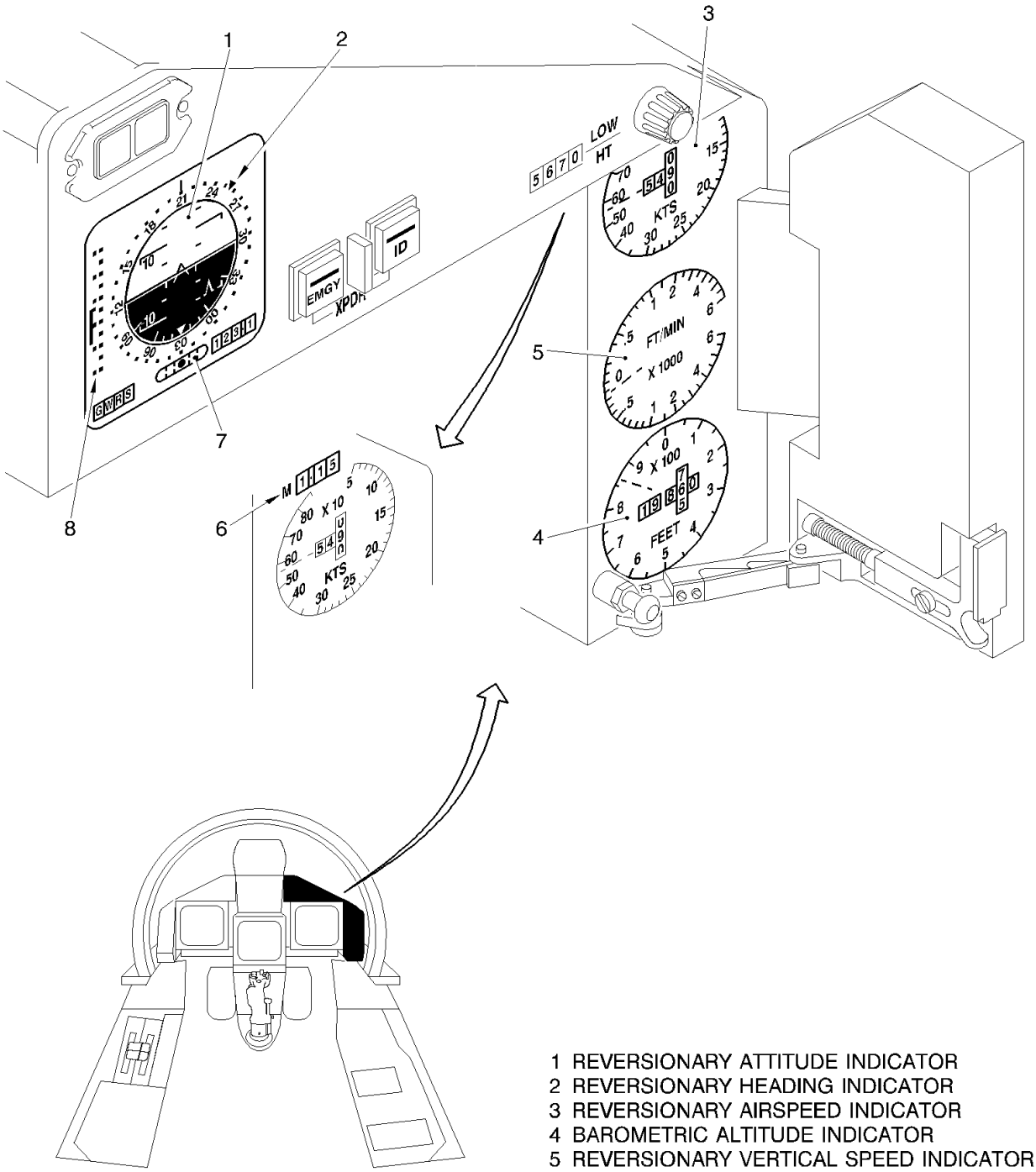
Reversionary Altitude Indicator

The reversionary altitude indicator comprises a circular analog indication, one complete revolution representing 1000ft in altitude, together with a digital readout of height up to 65 530ft. The instrument is marked x100 and FEET. The analog scale is marked in 50ft steps up to 950ft. The five digit digital readout, situated in the center of the instrument, indicates height in multiples of 10ft. The last three digits of the readout are coincident with that displayed on the circular scale. Negative height can also be displayed on this indicator limited to −1000ft represented by a ‘minus’ sign on the rolling digit.



1 FUEL READOUT DISPLAYS
2 RIGHT HAND ENGINE NL DISPLAY
3 RADIO 2 READOUT DISPLAYS
4 RADIO 2 CHANNEL SELECTOR
5 RADIO 2 VOLUME CONTROL
6 RADIO 1 READOUT DISPLAY
7 RADIO 1 CHANNEL SELECTOR
8 RADIO 1 VOLUME CONTROL
9 LEFT HAND ENGINE NL DISPLAY

Figure 1.78 - HUD Control Panel GUH Instruments



1 REVERSIONARY ATTITUDE INDICATOR
2 REVERSIONARY HEADING INDICATOR
3 REVERSIONARY AIRSPEED INDICATOR
4 BAROMETRIC ALTITUDE INDICATOR
5 REVERSIONARY VERTICAL SPEED INDICATOR
6 MACH NUMBER DISPLAY
7 SLIP INDICATOR
8 REVERSIONARY ANGLE OF ATTACK INDICATOR

Figure 1.79 - Right Glareshield GUH Instruments

Computer Symbol Generator

(1B-B-31-16-00-00A-043A-A Issue 005)

Introduction

The Computer Symbol Generator (CSG) is part of the Displays and Control (D&C) system and is located in the avionic bay. Its function is to produce the symbology displayed on the Head-up Display (HUD), Multifunction Head Down Display (MHDD), and provide the video output to the Video/Voice Recorder (VVR). The CSG is also the interface between aircraft systems and the D&C for video inputs and non catastrophic failure warnings.
There are two CSG fitted, CSG1 and CSG2, each capable of driving the MHDD and HUD. With the two position CSG toggle switch, on the right forward console, in the NORM position, the system automatically selects the on-line CSG and sets the other CSG to standby when power is applied. The standby CSG will automatically take over operation if a fault is detected in the on-line CSG, or when the CSG switch is selected to the REV position.

Operation

CSG1 is powered from AC busbar XP1 and CSG2 from AC busbar XP2. An internal power supply module converts the AC supply to the DC voltages required for CSG operation.
The CSG has a direct video link to the VVR. It receives and transmits data to other aircraft systems using the avionic, attack and Utilities Control System (UCS) databuses.
The CSG produces the outputs required for the HUD and MHDD operating in cursive, raster, or cursive in raster flyback modes. The symbology and video is displayed in green monochrome for the HUD and up to sixteen colors for the MHDD.
Six video signals can be fed to the CSG but only four are currently used. The four video signals, in raster format, are from:

– The HUD camera (color)
– The map generator (color)
– The radar system (monochrome)
– The FLIR system (monochrome).

Six video signals can be fed to the CSG but only four are currently used. The four video signals, in raster format, are from:

– The HUD camera (color)
– The map generator (color)
– The radar system (monochrome)

A monochrome ‘outside world’ picture is taken by a video camera, which is mounted on the forward end of the HUD assembly. The video is mixed with HUD symbology in the CSG and recorded on the VVR.
The combined image is also projected on the rear cockpit HUD.
The map generator video signal is one of the display options when using the Pilot Awareness (PA) format.
The radar outputs a Direct Data Link (DDL) video signal to the CSG when the radar system is in the ground mapping mode. This video signal is an optional display when in Attack format.
The FLIR video output is used to display FLIR imagery on the HUD and FLIR format.
The CSG provide the interface between aircraft systems and the warnings system (except catastrophic warnings, which are hard-wired direct to the DWP). When a failure is detected in a system, the CSG triggers the attention getters, the warning display on the DWP, where relevant, and the generation of attensons and voice warnings, via the Communication and Audio Management Unit (CAMU).
When the recording of display data is initiated, the CSG will multiplex the video signals from the MHDD, HUD and the HUD camera before sending them to the VVR.

Ground Proximity Warning System

(1B-B-31-18-01-00A-043A-A Issue 004)

Introduction

The Ground Proximity Warning System (GPWS) is not safety critical or mission critical. The information provided to the pilot is advisory and the pilot is responsible for performing the required pull-up maneuver to ensure the safe flight of the aircraft.
The GPWS uses data from the following systems:

– Laser Inertial Navigation System (LINS)
– Global Positioning System (GPS)
– Radar Altimeter (RAD ALT).

The GPWS is an integrated system that will accurately calculate the aircraft position relative to the ground from the data provided by the LINS, GPS, RAD ALT together with the terrain and/or obstacle map data loaded to the system.
The Flight Control System (FCS) provides supplementary information to the GPWS with regard to the aircraft configuration and ‘g’ limits. By comparing this and the data supplied by the LINS, GPS and RAD ALT with an aircraft dynamic model and the PDS defined Minimum Separation Distance (MSD), the system continually computes the ‘g’ required to clear the most critical terrain profile (ground and obstacle) within the flight path of the aircraft with allowances made for positional uncertainty, pilot reaction time and the time to roll the wings level.

If the GPWS predicts that a pull-up maneuver at or above the pre-defined ‘g’ limit is required to prevent incursion below the MSD the GPWS warning will be activated, at the same time a Pull-Up arrow is displayed on the HUD to aid the pilot in recovery of the aircraft.

Initialization

The GPWS initialization procedure is performed automatically by loading the MSD data via the PDS. The GPWS accepts MSD data over the range 0 to 5000 ft in 25 ft increments. Where no MSD value is loaded via the PDS, or a PDS download failure occurs, the MSD will default to a fixed value of 50 ft. There is no dedicated warning to inform the pilot if the MSD fails to load, although this would be indicated by means of the ‘PDS ERROR - D+C DATA’ prompt on the Autocue format. The MSD value in use is displayed on the Manual Data Entry Facility (MDEF) and Autocue format.

The GPWS Terrain Database and the Obstacle Database are loaded via the Ground Loading Unit (GLU). The pilot is informed if the data fails to load, is corrupted or if the aircraft ground Present Position (PP) is outside the area of definition of the terrain and/or obstacle databases via appropriate prompts on the Autocue format, refer to Table , “GPWS Autocue Format Indications,” on page 1-118 .

GPWS Autocue Format Indications

PROMPT	MEANING
GLU ERROR - GPWS TERRAIN DATA	Terrain data not loaded or corrupted.
GLU ERROR - GPWS OBSTACLE DATA	Obstacle data not loaded or corrupted.
GPWS ERROR - TERRAIN AREA DATA	Present position outside terrain data area.
GPWS ERROR - OBSTACLE AREA DATA	Present position outside obstacle data area.
GPWS MSD - 1000	Current MSD setting for the GPWS.
PDS ERROR - D+C DATA	Possibility that MSD has failed to load from the PDS.

Modes of Operation

The GWPS is operative in all Phase of Flight (POF), with the following provisos. The GPWS pull-up warning and the related HUD and Head down HUD (HDHUD) symbology, and the ‘TERRAIN DATA’, ‘TERRAIN VALID’, ‘OBSTACLE DATA’ and ‘OBSTACLE VALID’ warnings are inhibited when:

– When the aircraft has weight-on-wheels
– When in GND or T/O POF
– For 15 seconds after entering NAV POF from T/O POF (with weight-off-wheels)
– When the landing gear is selected down
– GPWS is set OFF on the MDEF
– The GPWS has failed.

There are four modes of operation:

– Primary mode
– Reversionary mode
– Acquisition mode
– Off mode.

The GPWS determines the mode of operation based upon the validity and availability of the input signal, the GPWS confidence level, height and map data validity and hardware status. This information is used to give an estimate of height and position uncertainty, refer to Figure 1.80. These uncertainties are given a Figure of Merit (FOM) and are indicated by a number between 1 and 5 inclusive; the greater the number the larger the uncertainty of aircraft height or position. Refer to Table , “GPWS Position FOM,” on page 1-119 and Table , “GPWS Height FOM,” on page 1-119 .

GPWS Position FOM

GPWS POSITION FOM	SYSTEM POSITIONAL UNCERTAINTY (FT)	SYSTEM POSITIONAL UNCERTAINTY (M)
1	0 - 158	0 - 48
2	170 - 250	52 - 76
3	262 - 328	80 - 100
4	342 - 472	104 - 144
5	>485	>148

GPWS Height FOM

GPWS HEIGHT FOM	SYSTEM TERRAIN CLEARANCE (FT)	SYSTEM TERRAIN CLEARANCE (M)
1	0 - 52	0 - 16
2	55 - 78	17 - 24
3	82 - 105	25 - 32
4	108 - 160	33 - 49
5	>164	>50

The pilot may view the system status by performing an X-Y insert over the PP symbol on the Pilot Awareness (PA) format. An additional data box is displayed that, amongst other information, shows the GWPS Height FOM and Position FOM.

Primary Mode

The Primary Mode is the normal operating mode with all required inputs assessed as being valid and within the specified accuracy. When operating in this mode GPWS height FOM and position FOM are equal to 1.

If the GPWS suffers a temporary loss of one or more of its sensors, e.g. RAD ALT input data due to the attitude of the aircraft, then the GPWS is able to minimize the effects of this temporary loss or intermittent sensor operation without inhibiting GPWS functionality.

Reversionary Mode

The GPWS enters Reversionary Mode when the height FOM and/or position FOM increase above 1 due to degraded information or error in the data supplied by the sensors.

As the FOM increase the larger the height and positional uncertainty of the aircraft, therefore a greater height is required for the aircraft to clear terrain and/or obstacles. When the FOM increase, the possibility of nuisance warnings also increases. There is no dedicated warning to indicate to the pilot that the Reversionary Mode has been entered.

Acquisition Mode

If the GPWS FOM increase above a critical value as a consequence of a failure of the GPWS sensors or a prolonged period of time without GPS, terrain/ obstacle or RAD ALT data input, the GPWS is automatically deselected and enters Acquisition Mode. In addition the Dedicated Warning Panel (DWP) GPWS warning and associated “GPWS” voice message are presented. The system will remain in Acquisition Mode until a position of sufficient accuracy is determined, whereupon the GPWS fail warning is reset and the system enters either the Primary or Reversionary Mode of operation, dependent upon height FOM and position FOM.

Off Mode

The pilot is able, via the MDEF, to switch off the GPWS. When selected OFF all of the GPWS warnings and symbology are inhibited, with the exceptions of the MSD value displayed on the MDEF and the Autocue format, the GPWS failure warning and the FOM on the PA format. The legend GPWS AVAIL is also presented on the PA and Horizontal Situation Indicator (HSI) formats to remind the pilot that the GPWS is available but has been selected to OFF.

Manual Data Entry Facility

GPWS moding key is available on selection of the MISC subsystem key, refer to Figure 1.82 The GPWS defaults to ‘on’, indicated by the GPWS legend being boxed on the GPWS/PAGE moding key following aircraft power-up, and valid navigation data becoming available.

The ROL will display the current MSD as defined via the PDS. If the MSD is not defined then a default height of 50ft is displayed.

Selecting the GPWS/PAGE moding key produces the GPWS sub-page, which shows two active moding keys, one of which is used to switch the system between GPWS ON and GPWS OFF.

With the GPWS ON legend shown on the sub-page, selection of the GPWS/PAGE moding key will return the system to the MISC subsystem default display.

If the system has been selected to GPWS OFF, the legend on the GPWS/PAGE moding key will be unboxed, and all GPWS warnings and symbology suppressed except:

– The GPWS fail warning and DWP caption

– The display of the MSD on the ROL
– The GPWS AVAIL and Figure Of Merit (FOM) indications on the PA format.

If the system has been selected to GPWS OFF and the GPWS/PAGE moding key is selected, it will return the system to the MISC subsystem default display showing the GPWS/PAGE moding key unboxed.

HUD Symbology

A ‘PULL-UP’ arrow, with its outer line flashing at 4 Hz, is displayed on the HUD if selected. The arrow is shown with its reference point centered on the aircraft symbol and is able to rotate around its reference point such that the arrow is always perpendicular to the horizon and points away from the ground, refer to Figure 1.81.
The arrow is accompanied by the breakaway cross on all the MHDD formats (except the HDHUD) and by the “PULL-UP” voice message. The ‘PULL-UP’ arrow will have precedence over the ‘LOW HEIGHT’ warning arrow.

Dedicated Warning Panel

GPWS warnings are shown on the Dedicated Warning Panel (DWP) with the associated voice warnings/messages shown in Table , “DWP Indications and Voice Warning/Messages,” on page 1-120 .

NOTE

In all conditions except GPWS failure, the warning will be suppressed when the GPWS is selected OFF at the MDEF.

NOTE

In all conditions except GPWS failure, the warnings are suppressed until 15 seconds after entering NAV POF from T/O POF (weight off wheels) and when undercarriage selected up in LDG POF.

DWP Indications and Voice Warning/Messages

DWP INDICATION	VOICE WARNING/MESSAGE	MEANING
GPWS	GPWS	GPWS failure
TERRAIN	TERRAIN DATA (CAT 3 - NAV, AA and LDG phase of flight)	GPWS terrain and obstacle data has been lost as aircraft is outside the terrain data defined area. GPWS will not be able to provide warnings to clear terrain.
TERRAIN (Goes out)	TERRAIN VALID (CAT 4 - NAV, AA and LDG phase of flight)	GPWS terrain data has been restored, the aircraft has re-entered the defined area. This message is dependent upon the DWP TERRAIN warning having previously been set.
OBSTACLE	OBSTACLE DATA (CAT 3 - NAV, AA and LDG phase of flight)	GPWS obstacle data has been lost as aircraft is outside the area where obstacle has been defined. The system will continue to provide warnings to clear terrain.
OBSTACLE (Goes out)	OBSTACLE VALID (CAT 4 - NAV, AA and LDG phase of flight)	GPWS obstacle data has been restored. This warning is dependent upon the DWP OBSTACLE warning having previously been set.
None	PULL-UP (CAT 1 - NAV, AA and LDG phase of flight)	This voice warning accompanies the PULL-UP arrow on the HUD when the warning is triggered.

Normal Operation

Terrain and Obstacle Warning

If, within the current flight path, the GPWS predicts that a pull-up maneuver is required at or above a predefined 'g' level, to prevent incursion below the total system clearance height above the terrain or

obstacle, then the voice warning “PULL UP” is activated. The total system clearance height includes both the predefined MSD and an allowance for the GPWS height and position uncertainties. The warning is generated such that there is sufficient time for the pilot to react, to roll the wings level (if necessary) and to perform a pull-up maneuver at or above the predefined ‘g’ level.

Simultaneously, the flashing pull-up arrow is displayed on the HUD. The arrow is shown with its reference point centered on the aircraft symbol and is able to rotate around its reference point such that the arrow is always perpendicular to the horizon and points away from the ground. To improve the pilots awareness of the situation the breakaway cross is also displayed on all the MHDD formats except for the HDHUD and DRF formats.

NOTE

The GPWS pull-up warning and the associated pull-up arrow will always suppress the low height warning and the associated low height pull-up arrow, i.e. the GPWS pull-up warning and arrow will have precedence.

Continuous monitoring of the pilot response is carried out during the pull-up maneuver by comparing the required ‘g’ with the achieved ‘g’. The GPWS warning will reset and the pull-up arrow will no longer be displayed, provided the aircraft has achieved the required trajectory that will allow it to clear the terrain or obstacle safely, and be outside of the total system clearance height.

Off Map

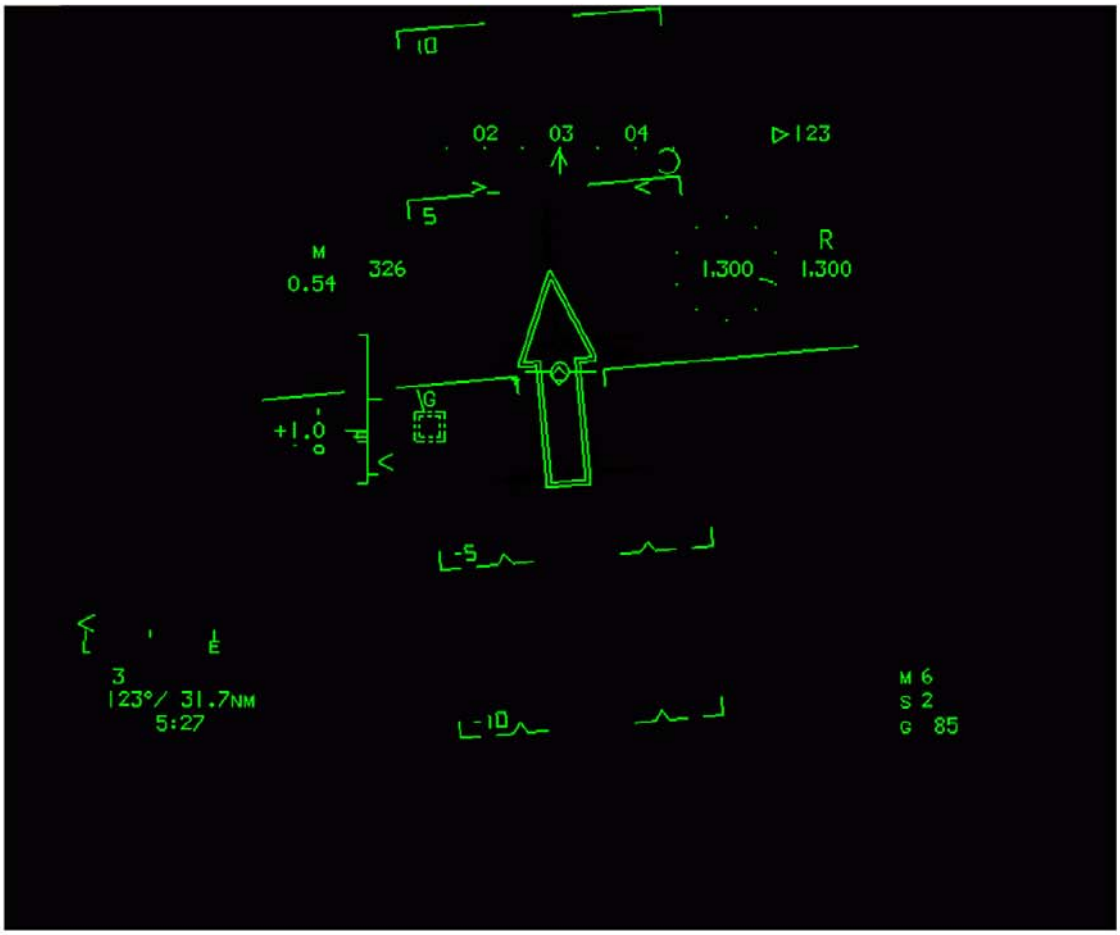
When the aircraft position or its predicted trajectory is outside the area where the GPWS terrain data is defined, the GPWS is not able to provide the pull-up warning to clear both the terrain and obstacles. The pilot is alerted to this condition by the DWP warnings ‘TERRAIN’ and ‘GPWS’ accompanied by the voice warning “TERRAIN DATA”. When the aircraft re-enters the defined area for terrain data then the GPWS pull-up warning function to clear both terrain and obstacles becomes available again, the DWP warning ‘TERRAIN’ ceases to be displayed and the pilot is informed by the voice message “TERRAIN VALID”.

When the aircraft position or its predicted trajectory is outside the area where the GPWS obstacle data is defined, the GPWS is not able to provide the pull-up warning to clear obstacles, although it continues to provide the warning to clear the terrain. The pilot is alerted by the DWP warning ‘OBSTACLE’, accompanied by the voice warning “OBSTACLE DATA”. When the aircraft re-enters the defined area for obstacle data then the GPWS pull-up warning to clear obstacles becomes available again, the DWP warning goes out and the pilot is informed by the voice message “OBSTACLE VALID”.

The terrain and obstacle warnings are inhibited when the GPWS is selected OFF at the MDEF or if the GPWS failure (DWP captions and voice warning) is triggered.

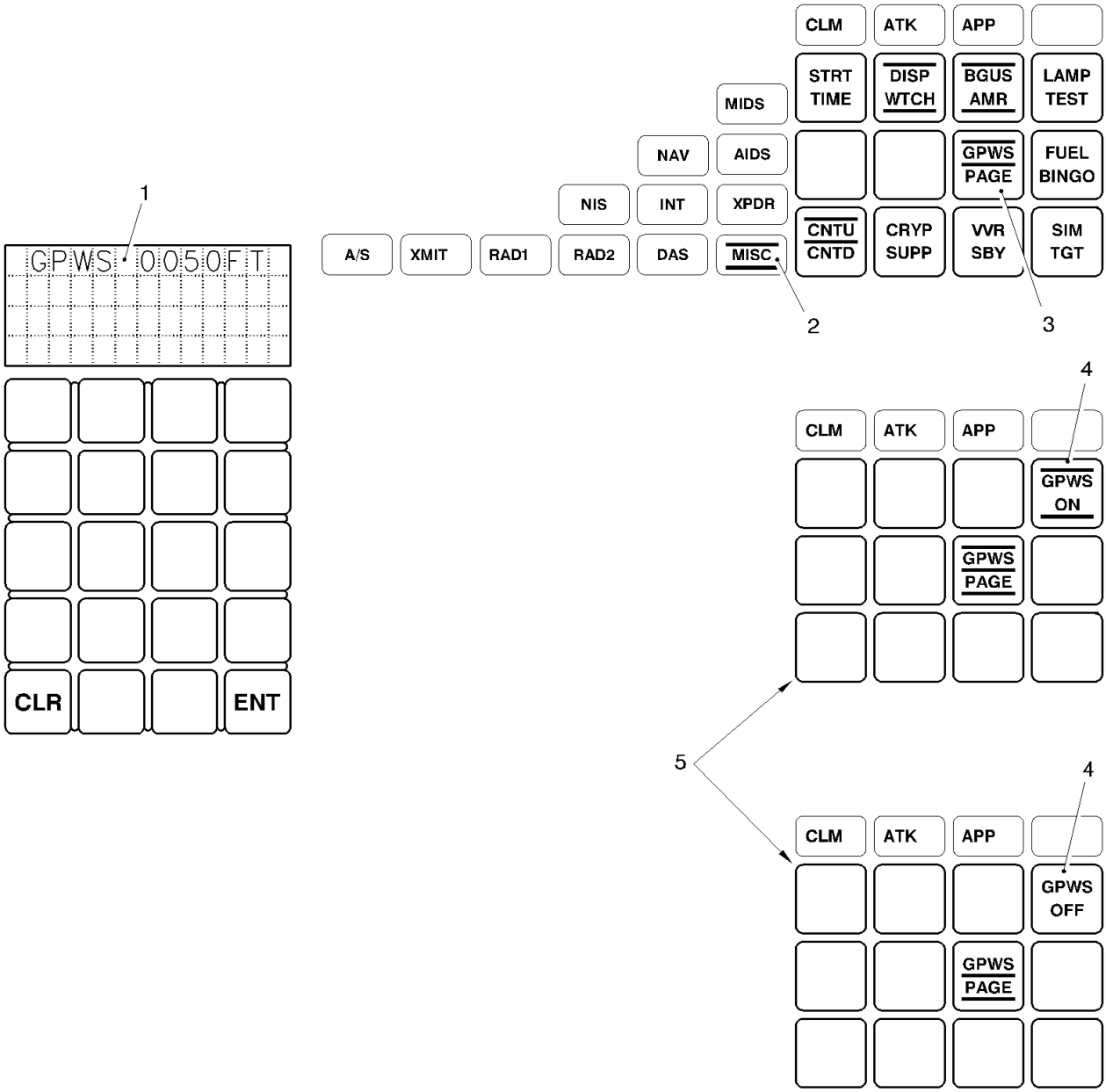
NOTE
'GPWS AVAIL' INDICATES THAT GPWS IS AVAILABLE BUT NOT SELECTED ON AT THE MDEF.

Figure 1.80 - Pilot Awareness Format (GPWS Indications)



NOTE
OUTER LINE OF ARROW FLASHES AT 4HZ. ARROW ROTATES ABOUT ITS REFERENCE POINT (AIRCRAFT SYMBOL) SUCH THAT IT ALWAYS POINTS AWAY FROM THE GROUND.

Figure 1.81 - HUD GPWS (Pull-Up Arrow)



1 ROL SHOWING CURRENT MSD
2 MISC SUBSYSTEM KEY
3 GPWS FUNCTION MODING KEY
4 GPWS ON/OFF MODING KEY
5 GPWS SUB-PAGE SHOWING GPWS ON/OFF

Figure 1.82 - GPWS Moding

UTILITIES CONTROL SYSTEM

Utilities Control System

(1B-B-40-41-00-00A-043A-A Issue 004)

The Utilities Control System (UCS) is a digital integrated control system consisting of seven computers connected to a dual redundant standby STANAG 3838 data bus.
The UCS Computers are the following:

– left and right Fuel Computers (alternately acting as Bus Controller)
– left and right Secondary Power System (SPS) Computers
– Front Computer
– Landing Gear Computer
– Maintenance Data Panel Computer.

The Bus controller functions are resident in both fuel computers. The computers communicate, via the UCS data bus, with themselves and with the:

– Avionic Display and Controls (D&C) Subsystem via two Computer Symbol Generators (CSG 1 and 2) and the Right Hand Glare Shield (RGS) for the front cockpit and the Right Hand Glare Shield Twin seat (RGS-T) for the rear cockpit
– Avionic Integrated Monitoring and Recording Subsystem (IMRS) via the Interface Processor Unit (IPU)
– Flight Control System (FCS) and indirectly with Propulsion System (PRP), via two Flight Control Computers (FCC 3 and 4)
– Secondary Power System (SPS) via the Auxiliary Power Unit/Control Unit (APU/CU)
– Electrical Power Generation System via the two Generator controller units GCU1 and GCU2.

Each UCS computer provides control, monitoring and testing of the systems or sub-subsystems allocated to it. The UCS incorporates Built-In-Test (BIT) functions to check the UCS computers as well as utility systems. IBIT of some non-UCS systems is also performed via the Maintenance Data Panel (MDP).
There are three types of BIT implemented PBIT, CBIT and IBIT:

– Power-up BIT, performed simultaneously by all UCS computers on power up
– Continuous BIT, performed automatically and/or under the control of the application software
– Initiated BIT, performed by all UCS computers with the exception of Brake and Anti Skid subsystems where it is initiated via the MDP.

All UCS equipment failures detected by the computers are stored in nonvolatile memory and transmitted to the IPU on the UCS bus and then to the MDP on the Direct Data Links (DDL). These failures are also recorded on the PMDS for later evaluation by the ground crew.
The UCS is powered by the essential DC bus bars PP3 and PP4. For ground maintenance, DC power can be supplied to the selected computers by means of the maintenance bus bar PP5.

UCS Computers

(1B-B-40-41-01-00A-043A-A Issue 004)

The UCS computers and software are designed primarily to support the general systems.

Front Computer

The Front Computer (FC) controls, monitors and tests the functions for the engine bleed air distribution subsystem, the air conditioning system, the windscreen and canopy system, the oxygen system, radar liquid cooling, control of dehumidification functions and monitoring of liquid conditioning for pilot vest, life support NBC; it also monitors and tests the crew escape and safety system. Electrical power to the FC is supplied by the essential bus bars PP3 and PP4 (or from maintenance bus bar PP5) and by the primary bus bars PP1 and PP2.

Control and Monitoring of Engine Bleed Air Distribution Subsystem

Engine bleed air from the 5th stage of the HP compressor is used for the environmental control system (ECS) and/or in cross bleed operation during single engine operation for the aircraft secondary power system (SPS) in the event of a single engine flame-out or failure.
A leak detection loop, which sends a signal to the UCS, is installed between the engine bleed SOVs and the pre-cooler. If a leak is detected the engine bleed SOVs (EBSOVs) are closed: as a consequence the air supply to all utilities is stopped. During normal operation all ECS monitoring and control functions are accomplished by the UCS front computer which contains the ECS software. If the ECS fails, the UCS front computer guarantees the flow of air to the MSOC and provides anti-g and canopy seal.
The pilot will select the ECS master switch (normally positioned to ECS) to RAM AIR which gives direct control of the fans, the fan SOV, the AVSOV, the three-way valve and the ERA valve.

Air Conditioning System

The FC controls and monitors the operation of the ECS shut-off valve (SOV), under normal operation this valve is open and allows pre-cooled air to flow the following subsystems:

– Cooling
– Temperature Control
– Avionic Compartment Air Distribution
– Center fuselage Compartment Air Distribution
– Cockpit Air Distribution
– Canopy and Windscreen Demist Air Distribution
– Equipment Dehumidification.

Cooling Subsystem

The FC commands the opening of the temperature control valve which lets air enter the cold air unit (CAU). If ram air is not available, for example when the engine is in the ground idle condition, the computer commands the inter-cooler ejector shut-off valve to open, allowing ram air into the inter-cooler. Opening and closing of the valve in flight is scheduled according to aircraft speed, altitude and angle of attack. The airflow temperature at the inter-cooler outlet is also monitored by means of a sensor.

Temperature Control Subsystem

The following temperature control system valves are controlled by the FC:

– Temperature Control Valve (TCV)
– Cabin Temperature Control Valve (CTCV).

The CTCV position is controlled by the Front Computer according to the cabin temperature selection and the outputs of the following sensors:

– ETC Temperature Sensor, Cabin Inlet
– ETC Temperature Sensor, Cabin Outlet
– ETC Temperature Sensor, Water Extractor Outlet.

The output of the following sensors are also fed to the FC:

– Inter-Cooler Outlet Temperature Sensor
– Pressure Sensor Cabin ECS Inlet
– Pressure Sensor Cabin ECS Inlet Differential
– Pressure Sensor Cabin ECS Inlet Absolute
– Pressure Sensor MSOC Heat Exchanger Inlet
– Differential Pressure Sensor MSOC Heat Exchanger
– Pressure Sensor Cabin Inlet Absolute
– Pressure Transducer, Cabin Absolute.

Avionic and Center fuselage Compartment Air Distribution

The cooling air for avionic and center fuselage compartments air distribution, the Front Computer monitors the position of the following valves, which are not controlled by the computer, but are opened or closed according to crew selection:

– Avionic Compartment SOV, also monitored by the RH SPS Computer (AVSOV)
– Cooling Fan SOV, Avionics Compartment (FAN SOV)
– Avionics Compartment Cooling Fan, also monitored by RH SPS Computer (AVSOV).

Cockpit Air Distribution

The Air Flow Control Valve (AFCV) is an infinite positioning valve which maintains the airflow to the cabin according to crew selections. In case of failure of the valve, a mid default value will be assumed (60°).

Canopy and Windscreen Demist Air Distribution

The following valves are under the control of the FC:

– Windscreen Demist Shut-off Valve
– Canopy Antimist Shut-off Valve.

Canopy System

The following functions for the Canopy System are monitored by the Front Computer:

– The integrity of the canopy open selection switches and associated wiring
– The integrity of the canopy close selection switches and associated wiring
– The canopy is down and locked, providing a warning signal to the pilot if the canopy is not locked. The CSG requires the throttle position to be greater than a predetermined limit (>75% NL) before it will display the CANOPY warning
– The status of the canopy providing a signal to the MHDD/ACUE format if the canopy is not locked
– The output of the pressure transducer on the canopy actuator manifold assembly
– Canopy accumulator pressure data is provided to the MHDD/HYD format for display.

Cockpit Ladder Monitoring

The pilot is informed on the MHDD/ACUE format whilst on the ground when the ladder door is unlocked. The status of the onboard ladder door is monitored and a warning is displayed on the MHDD/ ACUE format if the ladder is not properly stowed whilst in flight. There is also a hard wired cockpit indication.

Control and Monitoring of Life Support System (LFE)

The FC provides control and monitoring of the following LFE subsystems:

– Breathing gas
– Anti-g
– Liquid Conditioning Supply (aircrew)
– NBC.

Oxygen System

The FC selects automatically the auxiliary oxygen supply following a failure in the MSOG. The FC produces a warning signal when either the zirconia oxygen monitor (ZOM) or the paramagnetic oxygen monitor (POM) detect that the oxigen partial pressure falls below warning limits and selects the AOB. The FC monitors the position of the changeover valve in the AOB head and provides on DWP the MSOC or OXY warning. Pressure and temperature sensors of the auxiliary oxygen bottle (AOB) enable the FC to calculate the content of the bottle.

Liquid Conditioning for Pilot Vest

The FC controls and monitors the liquid conditioning system as part of the LIFE system. System monitoring and back-up protection is provided by the UCS.

Dehumidification Air

The ECS provides dehumidification air to the cockpit, avionic bay (front and centre fuselage) and radar bay while the aircraft is on the ground. Initiation of the dehumidification function (by the ground crew via the MDP) causes the FC/ECS to reconfigure the ECS valves to allow dehumidified air to pass through the system thus reducing/removing the humidity in the cockpit and the avionic/radar bay.

Monitoring of Crew Escape System

The FC monitors the following:

– Status of the Emergency Oxygen Selection handle
– ARMED/SAFE ejection seat handle position
– Position of the command mode selector (CMS) on two seat aircraft
– Safety Pins Stowage (seat and canopy)
– Seat ejected signal.

Landing Gear Computer

The Landing Gear Computer (LGC) performs control, interfacing, warning and indication generation, monitoring and test functions, associated with the following systems and their constituent sub-systems:

– Landing Gear System:

  Sequencing
  Indication
  Weight on Wheels
  Emergency Lowering

– Brake System:

  Brake Control
  Park Brake
  Brake Cooling

– Auxiliary Deceleration System:

  Brake Chute
  Arrestor Hook.

The LGC is a single line replaceable item (LRI) enclosing two fully separated systems, referred to as System 1 and System 2. System 1 is electrically supplied by the essential busbar PP3, while System 2 is supplied by the essential busbar PP4. Power from the PP5 maintenance busbar is used for ground maintenance functions.

Landing Gear System

Sequencing

The LGC controls the landing gear selector valve manifold to switch hydraulic pressure to the actuators of the landing gears, the nose door and the main doors dependent on pilot's demand and actual gear/door position. The LGC de-energizes the baulk solenoid to lock the landing gear selector in the "down" position when weight on wheels is reported from the related subsystem. The LGC provides continuous fault detection and isolation for the entire sequencing and all associated components.

Indication

The LGC controls the four display elements according to the actual gear/door positions. In addition the LGC turns on all display elements upon reception of a lamps test signal, coming via the data bus from the cockpit.

Weight on Wheels

Each system of the LDG independently controls the WOW relays dependent on the weight on wheel situation of the associated landing gears, the related relays always reflect the real weight on wheel conditions.
System 1 and System 2 have separate control of the WOW relays. It provides continuous fault detection and isolation for the entire weight on wheel subsystem. The LGC provides data on the state and the status of the entire weight on wheel subsystem collectively and individually to the UCS data bus and to other system/subsystem.

Emergency Lowering

Emergency landing gear extension is possible even in the event of total LGC failure. For the emergency lowering system the LGC monitors both the position of the emergency gear switch, the wiring continuity of the related control lines and the electrical power.

Brake System

Brake Control

The LGC provides a dual redundant, stand-by brake system, controlling and monitoring two fully independent hydraulic circuits. The relevant circuit is selected either by the pilot or by the computer itself, dependent on the results of supply pressure and/or failure monitoring.
The LGC controls the selected circuit, modulating the pressure at each brake via the related servo valves dependent on pilots demand and wheel speed information.
The LGC provides the following functions dependent on the actual aircraft speed:

– brakes metering below 10 kts
– adaptive skid control above 10 kts
– touch down protection
– locked wheel protection
– cross over wheel protection.

Park Brake

Selection is possible even in the event of total LGC failure. The LGC monitors the position of the park brake valve and monitors the status of the park brake accumulator.

Brake Cooling

The LGC system 1 fully automatically controls the operation of the wheel brake cooling fans, in order to reduce the turn-around time after a landing and in order to reduce brake heat pack temperatures during taxiing. Wheel brakes temperatures are kept low by cooling fans controlled by the LGC System 1.

Auxiliary Deceleration System

The LGC monitors the entire auxiliary deceleration system.

Brake Chute

Deployment and jettison of the brake parachute is possible even in the event of total LGC failure. The LGC (System 2) monitors state and status of the following components:

– brake chute switch
– chute lock and release unit
– door lock unit.

The LGC also generates the associated cockpit warning.

Arrestor Hook

Deployment of the arrestor hook is possible even in the event of total LGC failure. The LGC monitors the health of the arrestor hook release solenoids and detects the position of the arrestor hook and the position of the release button. It also generates the associated cockpit warnings.
In addition the LGC turns on the indicator within the release button upon reception of a lamps test signal, coming via the data bus from the cockpit.

Left and Right Fuel Computers

The LH and RH fuel computers automatically control and monitor the fuel system and moreover can operate as bus controller (BC) for all message exchange on UCS data bus A and B.
The LH and RH fuel computers control and monitor the Pressurization and Vent system, the Fuel Transfer system, Ground Refuelling and Defuelling, In-flight Refuelling, Fuel Gauging and Level Sensing.
The two fuel computers monitor the fuel levels, transfer fuel to satisfy all the maneuver and mission requirements and match the average fuel consumption to avoid excessive depletion of the main fuel tanks.
Temperature and pressure sensors provide signals for monitoring the pressurization system and data is processed by the fuel computers for display on the MHDD/FUEL format. Ground refuelling and defuelling procedures are initiated and monitored by the ground crew by using the MDP.
The LH fuel computer is electrically supplied by the PP3 essential bus bar. The RH fuel computer is electrically supplied by the PP4 essential bus bar. Power from the PP5 maintenance bus bar is used for ground maintenance functions.

Fuel Transfer System

The fuel transfer is fully automatic and it is controlled and monitored by the fuel computers by means of the signals received from the gauging and level sensing systems. The position and serviceability of the transfer valves is monitored by signals sent to the UCS from microswitches located in the valve actuator. Operation of the transfer pumps is monitored by pressure switches located at outlet of each pump. The status of the valves and pumps is continuously displayed on the MHDD/FUEL format and any failures are logged on the MDP.
The fuel transfer can be reconfigured by the pilot using the softkeys available on the MHDD/FUEL format.

Ground Refueling and Defueling

The refueling procedure is controlled by the UCS in response to commands from the MDP. The refueling procedure is normally terminated automatically by the UCS. Defuelling On-ground can be achieved by two different methods: Pressurized or Suction. The Fuel computers and MDP provide the necessary monitoring and control functions.

In-Flight Refueling

The fuel computers monitor and control the refueling process by means of the fuel level sensors and valves.

– The associated equipment of the in-flight refueling probe is checked for faults
– The state and condition of the cockpit IFR probe switch is checked
– Failure indications are generated should the probe fail to be mechanically locked in or out
– A warning that the IFR probe is not mechanically locked is provided on DWP.

Engine Feed

The fuel computers provide monitoring function for the following elements:

– Boost Pumps, Forward and Rear Fuselage Groups
– Engine Fuel Crossfeed Valve (only monitored by the LH Fuel Computer)
– Fuel Temperature sensor, Engine feed
– Low pressure fuel cock.

Engine Fuel Flow

The Fuel computers determine the fuel flow rates related to each engine. The fuel flow data are received from the DECUs and set to the fuel computers via the FCCs.

Fuel Gauging and Level Sensing

Capacitance measuring level and gauge probes, located inside the fuel tanks, provide analogue signals to the UCS fuel computers which determines the mass of fuel in each tank or tank group and provides a digital readout in Kg, on the MHDD/FUEL format and on HUP.
The Fuel Computers perform the following functions:

– Calculate the tank content
– Calculate tank levels
– Validate all probe and level sensor inputs
– Calculate fuel properties
– Generate fuel gauging outputs for display in the cockpit and the MDP and for use by FCS
– Provide low fuel level warnings for display in the cockpit
– Generate fuel level data for fuel management
– Fuel inertia calculation for FCS
– Monitoring of IFR probe.

AC/DC boost pumps dormancy check

The fuel computers monitor the status of the No.2 boost pumps and the associated pump outlet pressure sensors in the forward and aft fuselage tanks groups. The right No.2 boost pump (in the aft collector tank) has a dual motor AC powered during normal operation and DC powered when a double AC failure has occurred. The dormancy check is performed on the DC motor during the PBIT. If the DC motor fails during the PBIT or during the required DC operation, a “red pump” fail indication is shown on the MHDD/FUEL format.

Flight Control Functions

The fuel computers provide fuel center of gravity calculations to allow Flight Control System (FCS) to compute aircraft center of gravity (CG).

Left and Right SPS Computers

There are two identical and interchangeable SPS computers. The left SPS computer is electrically powered by the essential busbar PP3. The right SPS computer is electrically powered by the essential busbar PP4. For ground maintenance purposes, power is available from PP5 battery busbar. The SPS computers provides the following functions.

Secondary Power System

Ground Check Out

During this mode the SPS computers control and monitor the relevant gear box drive operation for electrical and hydraulic power generation using the APU or pneumatic ground cart.

Engines Starting in Main Mode

During this mode the SPS computers recognize the engine start request, control and monitor the relevant gear box and coupled engine acceleration up to engine light up using the APU or pneumatic ground cart.

Engine Starting in Alternative Mode

The alternative engine starting mode uses the same function as above but using the running engine pneumatic power source to power the ATS/M.

In-Flight Engine Flame Out (SPS Cross Bleed)

In this mode the SPS computers maintain the relevant gear box speed at 60% Nominal (± 4.5% transient) using the running engine pneumatic power source. Cross bleed is maintained operative, if previously initiated (i.e. loss of engine in flight) during landing and taxi in order to have full hydraulic and electrical power.

Assisted Engine Relight

During this mode the SPS computers engage the flame out engine and accelerate it up to engine light up speed using the running engine pneumatic power source.

Health Monitoring

During all operational modes health monitoring of the SPS Gearbox, ATS/M and CV, PTO Shaft, SPS PRSOV, Air Pressure Sensor and SPS Air Leak Sensors is provided.

Life Monitoring

During all operational modes, the following data is continuously monitored:

– ATS/M life consumption
– Gear box life consumption.

SPS Air Leakage Detection

Each SPS computer acquires eight temperature data in the surrounding of the pipe's V-clamps during both ground and flight operations. The internal process compares these data temperature values with a threshold of 250°C. If at least one of these values is greater than 250°C, the SPS LEAK caption is provided on the DWP. The related warning signals are also sent to the MDP indicating which sensor is involved.

Hydraulic System

The SPS computers provides the following functions.

Hydraulic Pump Depressurization

During engine starts the SPS computers control the hydraulic pump depressurization valve and in the case of malfunction provide failure data via the UCS data bus to the IMRS.

Utilities Isolation

The SPS computers control and monitor the utilities isolation valve to protect the associated flight controls circuit against pressure loss due to external leakage and moreover provide state and status data of the utilities isolation valve to the UCS data bus for use in other system.

Hydraulic Power Generation and Distribution

The SPS computers control and monitor the complete hydraulic power generation system. The SPS computers perform continuous fault detection and diagnosis of all hydraulic system components and provide the calculated state and status data to the cockpit (displays/warnings).

Hydraulics Warnings Suppression

To prevent nuisance warnings to the pilot during the start-up and shut-down sequence of the aircraft, the SPS Computer provides warnings suppression. The utilities and controls low pressure warnings (HYD TOT, L/R CONT P, L/R UTIL P) are not generated until gearboxes have reached a certain speed. This applies for normal data bus warnings, Get-You-Home warnings and the catastrophic double hydraulics fail warning.

Fire Protection System

The SPS computers monitor the outputs of the following:

– Engine Fire Detection System
– APU Fire Detection System (LH SPS computer only)
– Engine Fire Extinguishing System.

Each SPS computer monitors the outputs from their relevant Engine Fire Detection system. The LH SPS computer controls and monitors the APU Fire Detection/Extinguishing system. When fire is detected, the relevant computer provides a visual warning via the cockpit displays and audio warning.
The computers also provide the failure data to the integrated monitoring and recording system (IMRS). The SPS computers monitor the pressure of the fire extinguisher bottle and the electrical integrity of the electrical explosive devices (EED).

T2 Probe

Each SPS computer controls the activation of the T2 probe heater on ground. The controls is performed at the first time on power up, with engine not running and then during engine start when the engine speed achieved is 40% NH.

ECS Failure Warnings

The right SPS Computers monitor the cooling fans for the avionic equipment coding and transmit FAN warning when the cooling fans do not operate when required.

Life Support System

The left SPS computer provides monitoring of the Molecular Sieve Oxygen Concentrator (Paramagnetic Oxygen Monitor) and back-up monitoring of the Auxiliary Oxygen Bottle (AOB) and moreover provides the warning data to the cockpit displays and failure data to the IMRS.

Ice Detection

The left SPS computer controls and monitors the ice detection system and provides warning data to the cockpit and failure data to IMRS.

Maintenance Data Panel (MDP)

The MDP is the central point of the input/output for maintenance actions on the aircraft.
The MDP operates in two modes:

– On ground crew action
– During flight.

The purpose of the MDP is to allow rapid access to the aircraft maintenance data by the ground crew. The MDP will receive and record status, failure and fatigue data from aircraft systems. Data may be accessed by the ground crew upon request, either by the plain language display on the panel, and/or in a Portable Maintenance Data Store (PMDS) which shall be removed for ground analysis after flight.
The MDP performs five main functions:

– Recording
– Maintenance
– Data loading
– Monitoring
– Display.

During flight the MDP operates automatically; it receives the following maintenance and servicing data from aircraft systems and stores them on the PMDS:

– Aircraft identification
– System/LRI failure data (up to 5 flights)
– Exceedance data (last flight status)
– Engine health monitoring data
– Structure health monitoring data
– SPS life monitoring data
– SPS air leakage data
– Hydraulic trend data
– Event marker data.

On the ground, the ground crew can perform data collecting and then aircraft inspection.

UCS Data Bus and Interfaces

(1B-B-40-41-02-00A-043A-A Issue 005)

The seven UCS Computers are interfaced among each other and the equipment connected to the Data Bus by a dual standby redundant serial data bus.
Each part of equipment is connected as remote terminal (RT) to the data bus (refer to Figure 1.83).
The UCS exchange messages and data with various systems (e.g. avionics, cockpit, flight controls and propulsion).
The fuel computers control these transmission as bus controllers.

UCS - Data Bus

The method of communication of the UCS data bus and the electrical interface is according to the STANAG 3838 standard. The UCS data bus is a serial, dual, time division multiplex data bus, consisting of two shielded cables known as data bus A and data bus B, plus transformer couplers and stubs. The data bus interface circuits are inside the equipment connected to the bus.

Bus Controller

A bus controller (BC) is located in each Fuel Computer. Both of them are capable of performing the bus controller function in addition to their fuel system functions. The two UCS Fuel Computers can both operate, but not at the same time, as controllers of data flow for all transmissions on data bus A and B. While one Fuel Computer has control of the bus, the other computer operates as standby BC and also exchanges data as an RT.
When active as BC, each Fuel Computer directs data exchange over a preferred or primary bus, which is data bus A for the L/H Fuel Computer and data bus B for the R/H Computer.

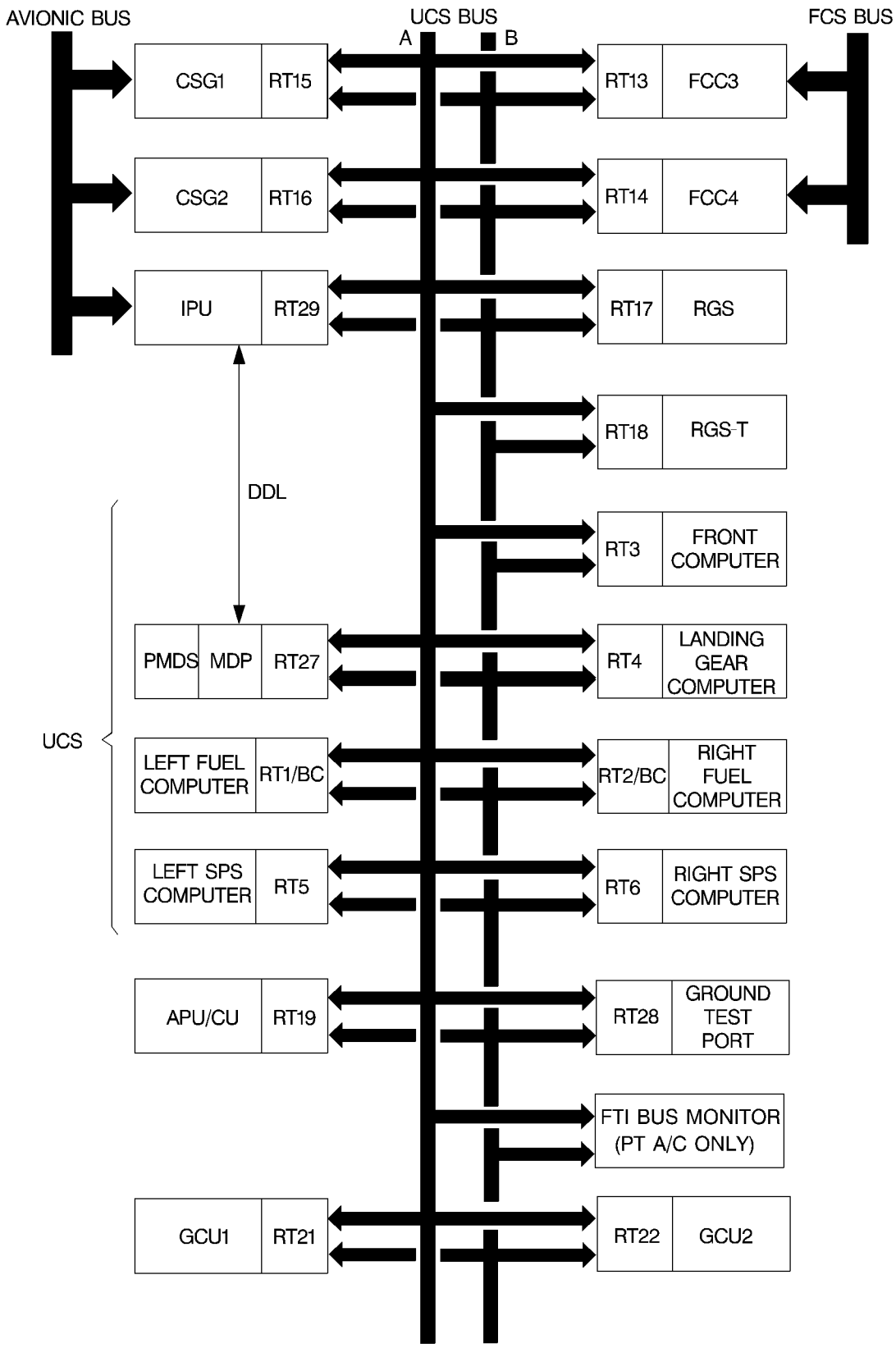


Figure 1.83 - UCS Architecture

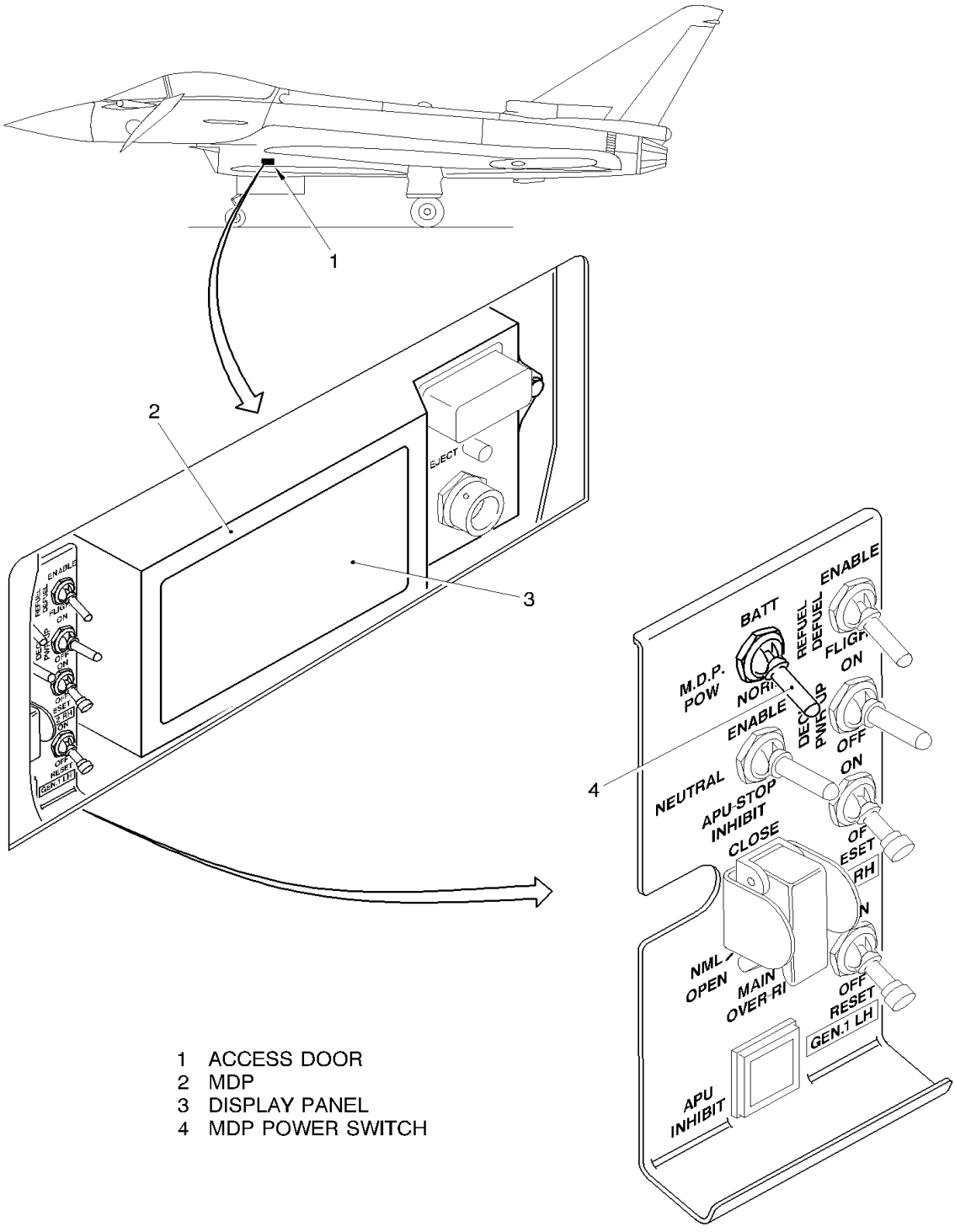
Maintenance Data Panel

(1B-B-40-41-03-00A-043A-A Issue 002)

Introduction

The Maintenance Data Panel (MDP), is the primary interactive interface between the aircraft and the ground crew, or pilot if the aircraft lands at a diversion airfield, during deliveries, transits or deployed operation. The MDP is located in the aircraft centre fuselage, refer to Figure 1.84, near the left engine air intake.

The MDP receives and records status, failure and fatigue data from aircraft systems. Data can be accessed by the operator upon request, either on a display panel, and/or in a Portable Maintenance Data Store (PMDS) that can be removed for analysis after flight.



1 ACCESS DOOR
2 MDP
3 DISPLAY PANEL
4 MDP POWER SWITCH

Figure 1.84 - Maintenance Data Panel

Main Functions

The MDP performs five main functions:

– Display
– Recording
– Maintenance
– Data loading
– Monitoring.

Display Functions

Following categories of data are accessible via the menu driven MDP touch-sensitive screen:

– System/LRI status and failure data (actual/last flight status)
– Limit exceedance data (actual/last flight status)
– Status of consumables (actual)
– Weapon system consumables (chaffs, flares, decoys, gun rounds) (last flight status)
– Weapon/stores configuration data (last ground crew input or last flight status)
– Lifed items.

Recording Functions

The PMDS records and stores the following information:

– Aircraft identification
– PMDS identification
– System/LRI failure data (up to five flights)
– Exceedance data (last flight status)
– Engine health monitoring data (last flight status)
– Structure health monitoring data (up to five flights)
– SPS life monitoring data (up to five flights)
– Hydraulic trend data (up to five flights)
– Event marker data (up to five flights)
– Harmonization data.

Maintenance Functions

The MDP has controls that allow the operator to perform the following maintenance actions:

– Aircraft inspections and turnaround
– Refueling/defueling
– Initiated Built-In-Test (IBIT) initialisation.
    • UCS subsystems:
        – Secondary Power System (SPS)
        – Brake system
        – Oxygen system
        – Environmental Control System (ECS)
        – Fire detection system
        – Utilities Control System (UCS) computers.
    • AVS Subsystems:
        – Navigation (NAV) System
        – Laser Inertial Navigation System (LINS)
        – Integrated Monitoring and Recording System (IMRS).
    • Propulsion:
        – Engine Monitoring Unit (EMU)
        – LH/RH Igniter.
– Initialization and display of status of de-humidified air function of ECS.

Data Loading Functions

The MDP touch-sensitive screen and the PMDS allows insertion of data for onwards transmission to the various aircraft systems and equipments, it is performed:

– Via the touch panel
– Via the PMDS.

Touch Panel

The following insertions can be performed:

– Manual input and uploading of the initial weapon/stores configuration data
– Initial data for SPS life monitoring
– Bulk storage device parameters.

PMDS

Uploading of aircraft related data:

– Configuration data
– Initial data for structural health monitoring
– Initial data for engine health monitoring
– Initial data for SPS life monitoring
– Harmonization data
– Bulk storage device parameters
– FCS basic mass empty and centre of gravity data.

Monitoring Functions

The MDP constantly monitors the UCS bus controller and records any anomalies.

Operation

The MDP can operate in two modes:

– Flight mode (during flight)
– Ground mode (when initiated by the operator).

MDP operation depends on the status of the access door. When the door is closed the Ground Service Panel Door switch (GSPD) is set to “on” and the MDP is automatically set to flight mode; when the door is open the GSPD switch is set to “off” and the MDP reverts to ground mode.

Flight Mode

Flight mode is established automatically by closing the MDP access door. In flight mode, the display is inactive and the MDP communicates with the IMRS and the UCS, provided that IMRS and UCS are powered up.

Ground Mode

When in ground mode, the MDP can operate in two sub-modes:

– Normal power mode
– Battery mode.

Normal Power Mode:

When electrical power is supplied to the aircraft, opening the MDP access panel activates the MDP in the normal power mode, this means that the full range of displays and menus are presented to the operator and communication with IMRS and UCS is established.

Battery Mode:

If only battery power is available, the MDP is activated when the MDP power switch, located on the panel adjacent to the MDP, is set to BATT. In battery mode, a reduced functionality of MDP menus and displays are available for power consumption reasons.
No IMRS communication is possible in battery mode and the interface to UCS requires the positive activation of the UCS bus controller (fuel computer) and UCS subsystem computers, dependant on the maintenance action demanded by the operator.
MDP ground mode is terminated by closing the MDP access door, this de-activates the display and physically forces the MDP power switch back into the NORM (normal) power position. If normal power is available, the MDP will be operating in flight mode.

Menu Selection

When the MDP is in ground mode, the operator can use the on-screen touch sensitive keys for interactive data transfer to and from the PMDS .
The operator can select any display items and initiate the control functions through a top down menu technique. This menu is based on a predefined dialogue using plain English in a easy to understood format with unambiguous abbreviations.

Built-In-Test (BIT)

These BIT procedures provide equipment monitoring during flight and testing on the ground. When an equipment failure is detected, relevant information is stored in a not volatile memory for later investigation after flight. There are three types of BIT, these are:

– Power-up BIT (PBIT) procedures
– Initiated BIT (IBIT) procedures
– Continuous BIT (CBIT) procedures.

Power-up BIT (PBIT)

At power-up and before entering the normal operational mode, the MDP executes the power-up BIT procedure. During power-up BIT the MDP does not generate any output. After BIT execution, the MDP processor goes into the operational mode, starting the MDP flight mode and the CBIT. The PBIT function is completed within 12 seconds.

Initiated BIT (IBIT)

IBIT is performed on request for maintenance activities. After execution of IBIT, the MDP reverts back to the operational mode selected before the IBIT was selected.

Continuous BIT (CBIT)

CBIT is automatically performed after the PBIT, it is a continous monitoring process of equipment functionality. The CBIT functions are executed automatically under control of system application software.

ENGINES

Engines

(1B-B-71-00-00-00A-043A-A Issue 005)

The aircraft is powered by two Eurojet EJ200 twin spool turbofan engines with afterburning capability (refer to Figure 1.85), installed side-by-side in two completely independent fireproof bays. The engines are fed with air by a variable-geometry air intake with two separate ducts located below the fuselage.
The thrust provided at maximum reheat range is equal to 90 KN.
The engine consists of a three stage LP (low pressure) compressor and a five stage HP (high pressure) compressor, each driven by a single stage turbine. Air bleeds are provided by both LP and HP compressors for internal cooling and aircraft services.
The airflow from the air intake duct is routed to the LP compressor and then it is divided into two streams, a hot main stream and a cold by-pass flow. The hot main stream passes in the inner portion of the fan section through the HP compressor and then into the annular combustion chamber, fitted with fuel spray burners. The cold by-pass air passes through an annular duct surrounding the HP compressor, the

combustion chamber and the turbine sections. Then it rejoins the main airflow in the jet pipe.

The afterburning system uses radial burners supplied via external manifolds, with a convergent-divergent (“con-di”) exhaust nozzle. The “con-di” nozzle consist of a multi-petal nozzle to provide a variable throat area, formed by the convergent petals, and a variable exit area, formed by the divergent petals. Nozzle external fairing flaps are provided to give an aerodynamic surface from the aircraft interface plane to the nozzle exit.

An engine mounted external gearbox, driven by the HP compressor, provides drives to the engine accessories and to the aircraft mounted gearbox.

The main engine and afterburning fuel metering systems are controlled by an engine mounted, fuel cooled Digital Electronic Control Unit (DECU), with engine monitoring and fault diagnosis capability.

An engine-mounted self-contained hydraulic system is driven by the engine gearbox. The lubricating system, consisting of the oil tank, pressure, scavenge and venting system, is completely self-contained on the engine.

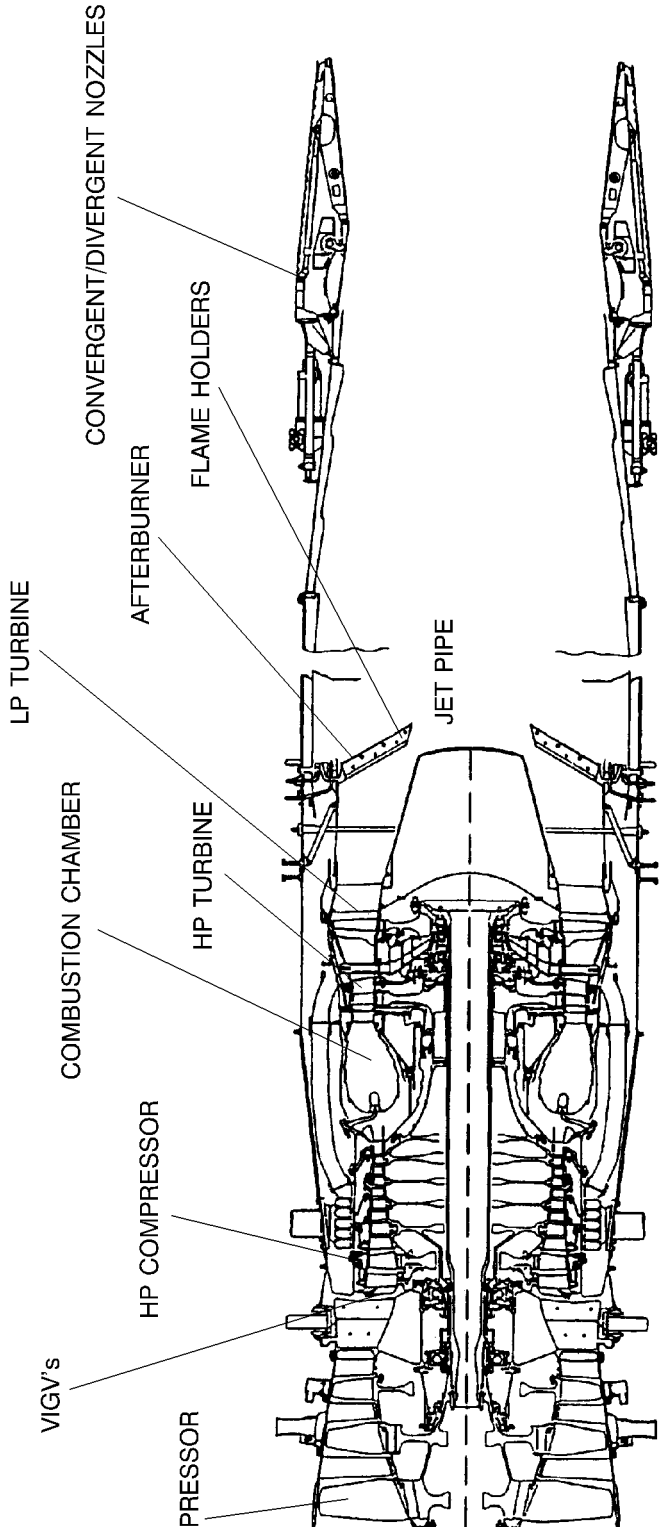


Figure 1.85 - EJ200 Engine

Engine Air System

(1B-B-71-83-00-00A-043A-A Issue 005)

A controlled air flow passes through the variable-geometry aircraft intake into the engine air intake where it is compressed by the three-stage LP compressor.

On exit from the LP compressor, the air flow is divided between the bypass and the main stream, in the ratio of nominally 0.4 to 1.

Main Stream Air Flow

The main stream air flow passes through variable inlet guide vanes and is further compressed by the five stage HP compressor before delivery to the combustion section.

The hot gas stream from the combustion chamber passes through single stage HP and LP turbines and the exhaust diffuser into the jet pipe where it joins the bypass stream air flow.

Bypass Stream Air Flow

The bypass stream air flows from the outer portion of the LP compressor through an annular bypass duct surrounding the HP compressor, the combustion chamber and turbine section. As the bypass air flow joins the hot gases, some of it flows through an annular passage between the front jet pipe and the heat shield, forming an insulating layer. Some air also flows through holes in the heat shield to provide a cooling flow on its inner surface.

Bleed Air

During operation of the engine, air is bled internally to provide engine cooling, pressurization and bearing load balancing. Air is also taken from the second stage of the LP compressor for fuel tank pressurization and from the HP compressor fifth stage to supply the aircraft services and air turbine starter motors of the aircraft secondary power system.

Engine Oil System

(1B-B-71-86-00-00A-043A-A Issue 005)

The lubricating system is completely self-contained on the engine. The oil system, fully aerobatics, provides the necessary lubrication and cooling for the bearings and gears. It is regulated by the engine speed to match the oil delivery to the engine requirements.

The system contains an aerobatics oil tank, a pressure subsystem, a scavenge subsystem and a venting subsystem. Its main components are the aerobatics oil tank, the pressure pump, the scavenge pump, the gearbox and the fuel cooled oil cooler.

The oil is delivered from the gearbox driven aerobatics oil tank by the pressure pump, through a fine filter and via a fuel cooled oil cooler to the engine to supply the bearings, gears and shafts with adequate lubrication under all operating conditions. The clear of the bearing chambers and the return of the oil to the tank is achieved by the scavenge pump system. The venting subsystem ensures an adequate airflow across the air seals, so that the oil is contained within the bearing chambers.

Aerobatics Oil Tank

This contains a rotating basket, driven by the external gearbox. The oil is held against the tank walls by centrifugal force, providing a continuous oil supply at all flight conditions, attitudes and accelerations.

The tank vent line contains a valve to seal (engine stopped) and pressurize (engine running) the oil tank.

Pressure Pump

A gear-type pressure pump driven by the external gearbox provides the pressure to drive the feed oil system. Suction performance at high altitudes is augmented by the pressurized oil tank. A pressure relief valve limits the cold start oil pressure.

The feed oil system main delivery areas are:

– Front Bearing Chamber
– Rear Bearing Chamber
– Gearbox.

When there is engine low pressure and/or engine oil over temperature conditions, the warning facility activates category 1 audio/warning to the pilot in the cockpit. These warnings consisting of flashing attention getter accompanied by voice warning message in the headset (left/right oil pressure and/or left/right oil temperature), and the relevant DWP and MHDD captions (Engine format, L/R OIL P or/and L/R OIL T) are displayed.

Scavenge Pump

A seven-stage gear pump driven by the external gearbox is provided for scavenging the system satisfactorily, up to the maximum operating altitude.

The pump also provides the pressure for the oil tank pressurization.

Gearbox

The external gearbox provides power for engine accessories and the aircraft gearbox, and also drives the rotating basket of the aerobatics oil tank.

Fuel Cooled Oil Cooler

Heat gained by the oil in the engine and gearbox is transferred to fuel being delivered to the engine through a heat exchanger in the fuel cooled oil cooler (FCOC).

Engine Fuel Control System

(1B-B-71-81-00-00A-043A-A Issue 005)

Fuel is supplied to the main fuel metering unit (MFMU) for dry range operation, and to the reheat section when required.

Fuel is also used to cool the digital engine control unit (DECU) and the lubricating oil through the FCOC.

Dry Range Fuel Supply

Dry range fuel supply is fed from the gear pump to the MFMU, where the main metering valve (MMV) sets the engine fuel flow. In the event of loss of control of the MMV, the DECU controls fuel flow to the engine via the emergency spill valve (ESV).

A drain tank collects fuel from the reheat pump following reheat cancellation and from the main manifold purge on engine shut-down.

Reheat Fuel Supply

Reheat fuel supply is completely controlled by the DECU. Moving the throttle to the reheat range allows fuel to the reheat fuel metering unit (RHFMU) and from there through distribution valves to the core, primary and bypass manifolds. Fuel flow is controlled by servo-driven metering valves which react to throttle position under DECU control.

Digital Engine Control Unit

(1B-B-71-84-01-00A-043A-A Issue 006)

The Digital Electronic Control Unit (DECU) is fuel cooled and mounted on the LP compressor casing. Its main function is to control the engine according to demands from the throttle in reference to TAS, OAT, VIGV position, and nozzle area to ensure engine function within its operational limitations throughout the flight envelope.

During normal operation, signals from the aircraft systems plus speed, pressure and temperature signals from the engine are fed into the DECU. Here they are analyzed, compared with limitations and demands, processed and used in the engine control system. The DECU carries out an “on engine” fault detection, using built-in test information, and provides this information to the aircraft mounted Engine Monitoring Unit (EMU). It also supplies data to the Maintenance Data Panel (MDP).

The DECU has a modular construction. It operates on a 28 V DC supply, energized by a throttle movement from shut to idle (or above) position.

The DECU is divided into two lanes (physically separated; lane 1 and 2), each identical, and both lanes are electrically powered (PP3 for lane 1 and PP4 for lane 2) at all times with only one lane required to control the engine.

Engine overspeed protection against DECU processing faults is provided by means of an independent analogue overspeed governor within each DECU lane.

This will limit engine fuel flow if either NL or NH exceeds preset thresholds. There are two high energy (HE) igniters, each individually controlled by a single lane for ground starting. If the engine does not accelerate above 30% NH within 25 seconds, the DECU will energize the second igniter. Alternate lanes of the DECU are selected for engine control at each DECU power-up. During in-flight relighting both igniters are energized.

Aircraft system and engine signals (speed, temperature, VIGV's position and nozzle area) are monitored by the DECU. These signals are processed and then used for engine control.

The DECU contains a surge recovery logic which comes into effect automatically. If automatic surge recovery is not successful pilot action will be required.

Cockpit Selections

The pilot can change the DECU lane using the two L1/L2 soft keys on the MHDD/ENGINE format, can be operated by . The lane change can only be performed if the stand-by lane is not more degraded than the active lane.

A signal will be transmitted to the MHDD/ENGINE format advising whether Lane 1 or 2 is operative. If both lanes have failed a L/R DECU warning is triggered and the engine control is lost. In this case the engine will automatically continue to operate at a safe rating (flight idle). Throttle movement has no effect.

DECU Functions

The DECU Built-In Tests during engine starting, normal operation, and on engine shut-down, perform the following functions:

– functional monitoring of the engine systems, preflight and continuous monitoring during operation
– test to isolate failures to individual LRIs
– provide data to the integrated monitoring and recording system (IMRS) to indicate the serviceability status of the engine.

BIT data are routed to the EMU.

Engine Monitoring System

(1B-B-71-84-02-00A-043A-A Issue 005)

The Engine Monitoring System (EMS) forms part of a total on-board Integrated Monitoring and Recording system (IMRS) that includes all aircraft systems, engines and equipment on aircraft.
The engine monitoring system consists of an Engine Monitoring Unit (EMU) which receives signals from DECUs. It provides on-board data processing during operation, so that relevant data is available for maintenance.
The engine monitoring system monitors the functional status of the engine, displaying information to the pilot and MDP.

NOTE

The PMDS (Portable Maintenance Data Store) is a unit that enables the data from the MDP to be transferred to the CSG and it can also be used to upload the engine monitoring system with data such as the engine configuration.

Data for the Crash Survivable Memory Unit (CSMU) is supplied from the DECU via the FCS bus.

Engine Starting System

(1B-B-80-00-00-00A-043A-A Issue 006)

The engine starting system provides to ignite the engine and accelerate it to a point of self-sustained stable running.
Starting engines may be performed:

– on ground
– in flight

Engine starting on ground

Ground starting of the engine is achieved by means of SPS system (refer to Secondary Power System pag. 1-153 for more details), or ground cart or by cross bleed when an engine is already running (refer to Crossbleed Engine Start pag. 2-15).
During ground starts, automatic monitoring of NH and TBT is carried out by the DECU and the start is terminated if certain criteria are not met.

SPS system ground starting

Starting is initiated by moving the throttle from HP SHUT to IDLE with LP COCK switch set to OPEN.
The LP COCK switch also acts as ignition master switch.
With the AIR DRIVE switch set to AUTO, air supplied from either auxiliary power unit (APU) or a ground supply, drives the gearbox via the air turbine starter motor (ATS/M).
The gearbox mechanically drives the engine and when a self-sustaining speed value is reached, the air supply to the ATS/M is cut off and the engine takes over the gearbox drive. After the second engine start, the APU is automatically shut-down or ground supply is cut-off.

Cross bleed ground starting

Cross bleed starts may be similarly carried out from a running engine by deselecting the APU beforestarting the second engine.
The running engine provides mechanical power via gearboxes and POT shaft to the other engine for starting.

Engine Starting In Flight

In case of engine unlit in-flight, an automatic restart is initiated by the DECU, without pilot actions and being throttle at IDLE or above, when:

– NH $\leq$ 60%
– Engine deceleration rate above maximum limit
– No deceleration is demanded by the control loop

If automatic restart fails, the pilot may perform:

– Windmill relight (refer to Double Engine Flame-out pag. 3-9)
  The engine spool rotation is induced by the air flowing through the unlit engine.
– Assisted relight (refer to Assisted Relight pag. 3-11)
  The engine spool rotation is caused by the air spilled from the live engine via cross bleed.

NOTE

During assisted relight and windmill relight automatic monitoring of TBT and NH is not carried out by DECU. TBT and NH must be monitored by the pilot.

Turbine Blade Temperature (TBT) Monitoring

If during ground start cycle TBT exceeds 610° C for longer than 2.5 seconds, fuel flow is reduced for 0.35 seconds. After fuel dip has occurred, fuel flow will return to the normal start schedule value, unless the start is cancelled manually or automatically.

Engine Airflow Control System

(1B-B-71-83-01-00A-043A-A Issue 004)

A self-contained hydraulic system controls the air flow through the engine by modulating the High Pressure Compressor (HPC) Variable Inlet Guide

Vane (VIGV's) and the convergent-divergent exhaust nozzle. The air flow control system consists of three sub-systems:

– hydraulic power generation unit (HPGU)
– variable guide vane actuation and control unit (VACU)
– nozzle actuation and control unit (NACU).

The hydraulic power from the pump to the VIGV's and nozzle actuators is controlled by separate servo valves for each sub-system, according to DECU demand.
Feedback of the VIGV's and nozzle position is supplied to the DECU. (Refer to Figure 1.86).

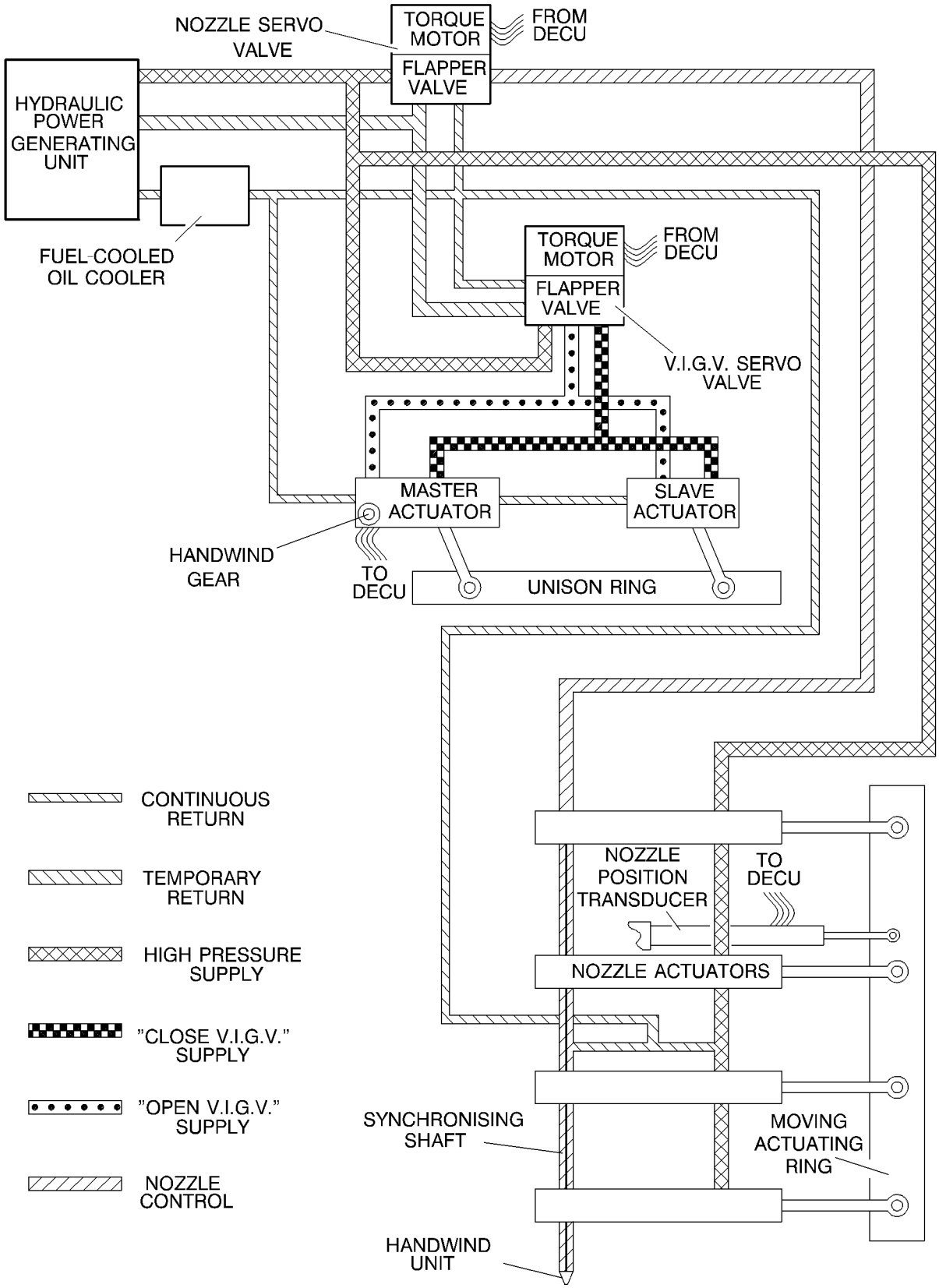


Figure 1.86 - Engine Airflow Control System Schematic Diagram

Engine Reheat System

(1B-B-71-88-00-00A-043A-A Issue 004)

The reheat system augments engine thrust by injecting fuel into the engine exhaust section. Selection of the reheat system is achieved by moving the throttle levers beyond the MAX DRY detent.

During reheat operation fuel is injected into both the hot gas exhaust stream and the by-pass stream. The reheat system uses radial burners supplied via external fuel manifolds, and includes a multipetal convergent-divergent nozzle capable of varying both the throat and exit areas.

Both the main engine and the reheat hydro-mechanical fuel metering units (RHFMU) are controlled by a fuel-cooled Digital Electronic Control Unit (DECU) with fault diagnosis capability.

Reheat Fuel Control

Pilot demand from the throttle levers produces an electrical signal which is routed via the FCS bus to the DECU. In response the DECU controls the engine by sending signals to fuel system electrical components. In most cases, a transducer produces positional feedback of the corresponding mechanical components to the DECU.

Reheat Fuel Supply

Fed by the reheat pump in response to a DECU signal, fuel passes through a gearbox driven centrifugal pump and into the reheat fuel metering unit (RHFMU). The reheat is lit by a hot shot injector, fed from an accumulator charged with fuel from the servo system and fired by a solenoid valve on receipt of a DECU signal. Fuel from the reheat fuel metering unit is fed to the primary, core and by-pass manifolds by distribution valves which pressurize the system, to minimize reheat light-up time. They also limit fuel leakage into the jet pipe on reheat deselection.

Reheat Operation

In the reheat range, the throttle setting demands on appropriate nozzle area which in turn schedules reheat fuel flow (three stage reheat fuelling: primary, core and by-pass).

Total temperature, altitude and the turbine pressure ratio are additional parameters governing reheat operation.

The engine handling in the reheat range is controlled as follows:

– For steady state condition by nozzle area (A8) demanded by throttle setting
– For transient conditions the reheat modulation is limited by nozzle area rate (A8 Dot).

The reheat selection sequence is inhibited if the engine speed is below 85% NH but, once lit, the engine speed is allowed to reduce to 80% NH before automatic reheat cancellation.

No special limitations are imposed on reheat handling. However, when operating above 30 000 ft at subsonic speed there is a possibility of transient buzz.

In any case the DECU will automatically cancel the reheat if the level of buzz or screech exceed the detection system limits.

Air Intake Cowls

(1B-B-71-60-00-00A-043A-A Issue 005)

General

Two air intake cowls, one on each engine intake are hinged at the lower lip of the air intake ducts. The left air intake cowl is powered through the left utility hydraulics circuit and simplex controlled by FCC 3 and monitored by FCC 1. The right intake cowl is powered through the right utility hydraulics circuit and simplex controlled by FCC 2 and monitored by FCC 4.

Control Laws

The Air Intake (varicowl) control law provide an automatic mode of cowl control. This standard of automatic control mode provides control of the cowl position:

– For engine ground running.
– At low speed and subsonic high incidence flying as a function of Mach number and incidence.
– During cruise at subsonic and supersonic speeds as a function of Mach number and total temperature.

Automatic Mode

The automatic cowl schedule is shown in Figure 1.87.

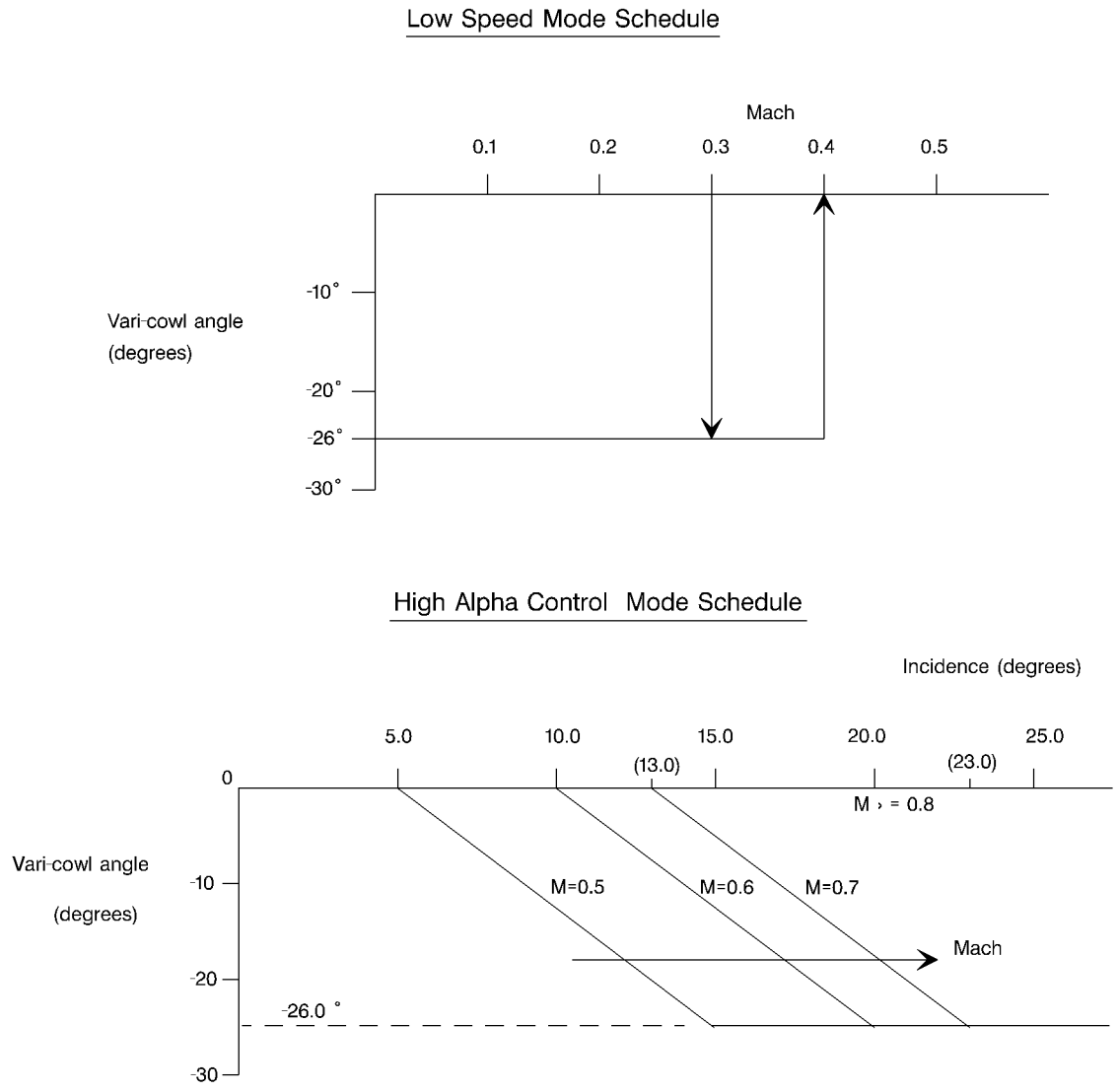


Figure 1.87 - Automatic Cowl Schedule

Manual Mode

In order to provide a back-up mode to the intake cowl automatic control system, the cockpit is equipped with an emergency intake cowl opening system, controlled by an emergency INTAKE open switch. Operation of the switch allows one or both cowls to be opened in the event of a failure condition as follows:

– When the switch is in AUTO position, the cowls are under automatic control.
– With one or both HYD/UTILS systems depressurized and with the emergency INTAKE switch held in the OPEN position, the appropriate intake (s) will be selected to OPEN. The cowls can be opened to the required setting (-26°) for landing.

Controls and Indicators

Dedicated Cockpit Control

INTAKE emergency control switch (left console), refer to Flight Control System (TWS) pag. 1-256.

MHDD

COWL position is indicated on the MHDD/ENG format.

DWP

L COWL or R COWL NAV, COMB & APP/LDG POF.

L COWL or R COWL GND & T/O POF

For more details refer to Air Intake Cowl Failure pag. 3-39.

Engine Operation

(1B-B-71-01-00-00A-043A-A Issue 004)

At high power the engine may be limited by NH, NL, NL/$\sqrt{\Theta}$, P3, T3, TBT or Nozzle Actuator Load (NZL). The exact regions for each limiter will vary from engine to engine (Refer to Figure 1.88).

At medium speeds TBT will be in control at all altitudes. The NL/$\sqrt{\Theta}$ controls at low speed and high altitude although it can control down to sea level on cold days.

During transients the DECU controls the engine acceleration/deceleration by limiting the NH dot. The extreme right hand side of the envelope is controlled by NH, P3, T3 or nozzle load, depending on the engine quality and ambient conditions.

At idle, the idle schedule, which may be overridden by the high power limiter, ensures efficient operation at all flight conditions.

At the right hand side of the flight envelope, the DECU will automatically inhibit reheat reselection in the event of hydraulic system (nozzle actuator) failure or reheat flame out to prevent any damage to the reheat system.

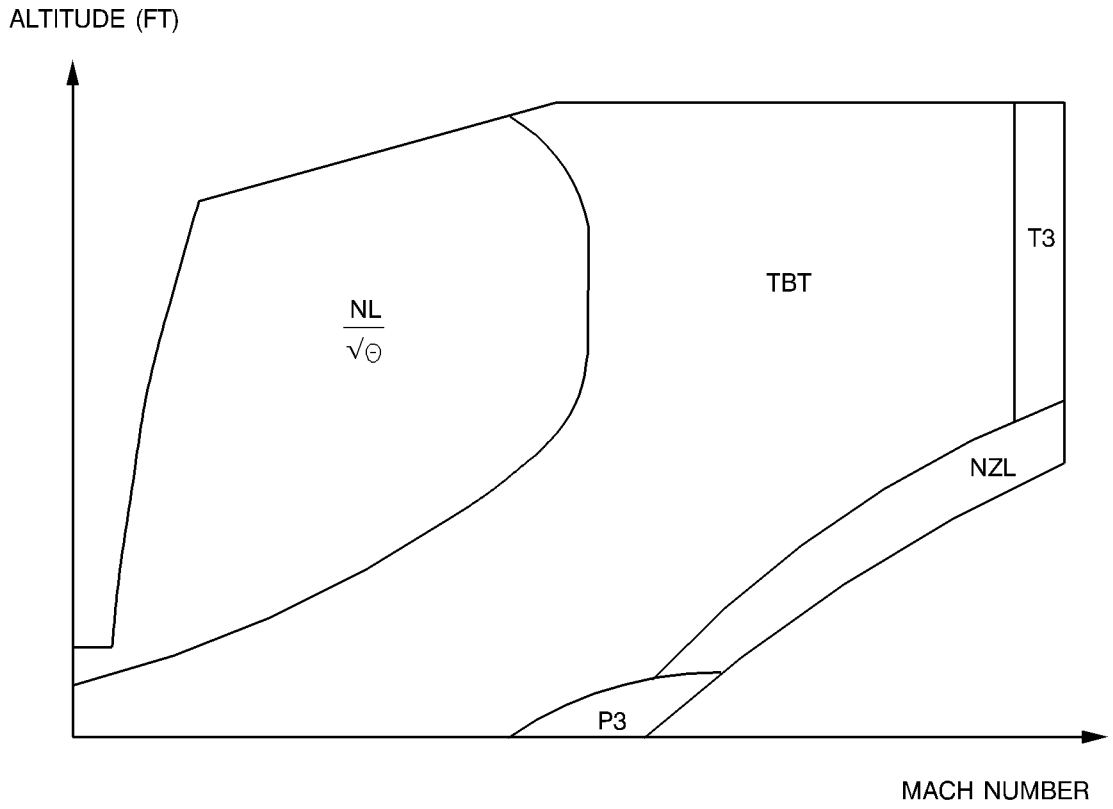


Figure 1.88 - Engine Limiters around the Flight Envelope

Engine Handling in Flight

(1B-B-71-02-00-00A-043A-A Issue 006)

The engine is controlled electronically, with various parameters governing engine behavior in different flight conditions.

In general, there is a fixed relationship between the throttle setting and NL, but changes in temperature, altitude and airspeed, which will normally cause variations in NH, TBT and AJ, may also cause small variations of NL for any given throttle setting.

In particular, the engine NH idle speed is scheduled with Mach, altitude and temperature. Thus, while stationary on the ground, the idle NH is normally between 67% and 72%; at high altitudes or in supersonic conditions, this can increases to MAX DRY.

Consequently a throttle response deadband may be noted in the idle region (due to the idle schedule).

Dry Power Operation

Engine handling in the dry power range is controlled as follows:

– For steady state conditions by NL from throttle setting being subject to minimum and maximum limits of NH, NL, NL/$\sqrt{\Theta}$, P3, T3 and nozzle load
– For transient conditions the accelerations/ decelerations are limited by NH rate (NH Dot).

Reheat Operation

In the reheat range, the throttle setting demands an appropriate nozzle area which in turn schedules reheat fuel flow.

Total temperature, altitude and the turbine pressure ratio are additional parameters governing reheat operation.

The engine handling in the reheat range is controlled as follows:

– For steady state condition by Nozzle Area demanded by throttle setting
– For transient conditions the reheat modulation is limited by Nozzle Area rate.

The reheat selection sequence is inhibited if the engine speed is below 85% NH but, once lit, the engine speed is allowed to reduce to 80% NH before automatic reheat cancellation.

No special limitations are imposed on reheat handling. However, when operating above 40 000 ft at subsonic speed there is a possibility of transient buzz.

In any case the DECU will automatically cancel the reheat if the level of buzz or screech exceeds the detection system limits.

Throttles

(1B-B-76-11-00-00A-043A-A Issue 003)

Introduction

The left and right throttle box units are mounted on the left console in both cockpits (Figure 1.89). They are functionally identical, except for the throttle top controls. The throttles are electronically controlled, to provide mass balancing, friction control and consistent reheat detent forces under all throttle movement conditions. Throttle lever friction can be adjusted to pilot comfort by operation of a rotary control, labelled THROTTLE FRIC, located on the left hand quarter panel. Full throttle box functionality is available when the battery master switch is set to BATT.

NOTE

The throttles in the front and rear cockpits are slaved to each other through the autothrottle actuators once the FCS is engaged in flight mode. Thus, the throttle position in both cockpits is the same, irrespective of which cockpit has FCS control. However, prior to FCS engagement, rear cockpit throttle movement has no effect on engine control or starting.

The left and/or right engine setting is achieved by moving the left and/or right throttle levers respectively. There are three regions of throttle movement, the HP SHUT sector, the dry power sector and the reheat sector.

HP SHUT

To allow movement of either throttle to HP SHUT from within the dry power range, a mechanical latch on the throttle box must be pressed. With a throttle at HP SHUT, the HP cock is closed and the engine, if running, is shut down and any ongoing start or relight sequence is cancelled.

In the front cockpit a manual release latch, which must be physically lifted to allow movement, prevents inadvertent start or shut down of the engines.

NOTE

The throttles cannot be selected to HP SHUT and the engines cannot be started or shutdown from the rear cockpit.

In the rear cockpit the manual release latches are not fitted. This allows unrestricted movement of the throttles from the HP shut position.

DRY Range (IDLE to MAX)

With the air drive switch at AUTO, and a gearbox air supply (i.e. APU running, external ground air cart connected or a running engine) moving a throttle from HP SHUT into the dry range initiates engine start. The start sequence is automatically controlled by the engine DECU. The pilot can start either engine in sequence, or open both throttles together, in which case the first engine detected as moving from HP SHUT to IDLE will be started first. The second engine will be started when the first start sequence is completed.

Reheat Range (MIN/MAX RHT Range)

The end of the dry power range is felt by a force detent, which must be overcome to select reheat. Similarly, cancelling reheat requires the pilot to pull through a force detent to regain the dry power range.

Autothrottle

Autothrottle is engaged by pressing the AT engage button (Figure 1.89) on the right hand throttle top, for less than one second. Pressing the switch for more than one second, changes the laws between Mach and IAS hold. With autothrottle engaged, throttle position is varied automatically to maintain the set speed datum. If the throttles are in the dry power range but reheat is required to achieve or maintain the datum speed, a Category 4 voice prompt, Select Reheat, is triggered. The pilot is may then manually push the throttles through the reheat detent, whereupon the autothrottle will control them as necessary. No pilot input is needed to retard the autothrottles from reheat into the dry power range.

The pilot can override autothrottle commands by force if necessary. This will result in an autothrottle disconnect and the generation of autopilot and autothrottle warnings.

The non-controlling pilot can override the controlling pilots' throttle settings, by pressing and holding his autothrottle engage switch for as long as he wants, in order to take throttle control.

An indicator labeled SPD, located on the left glareshield, illuminates when the AT is engaged and status bars on the AT mode selector indicator display either M (Mach) or Displayed Air Speed (DAS) dependent upon which mode is selected.

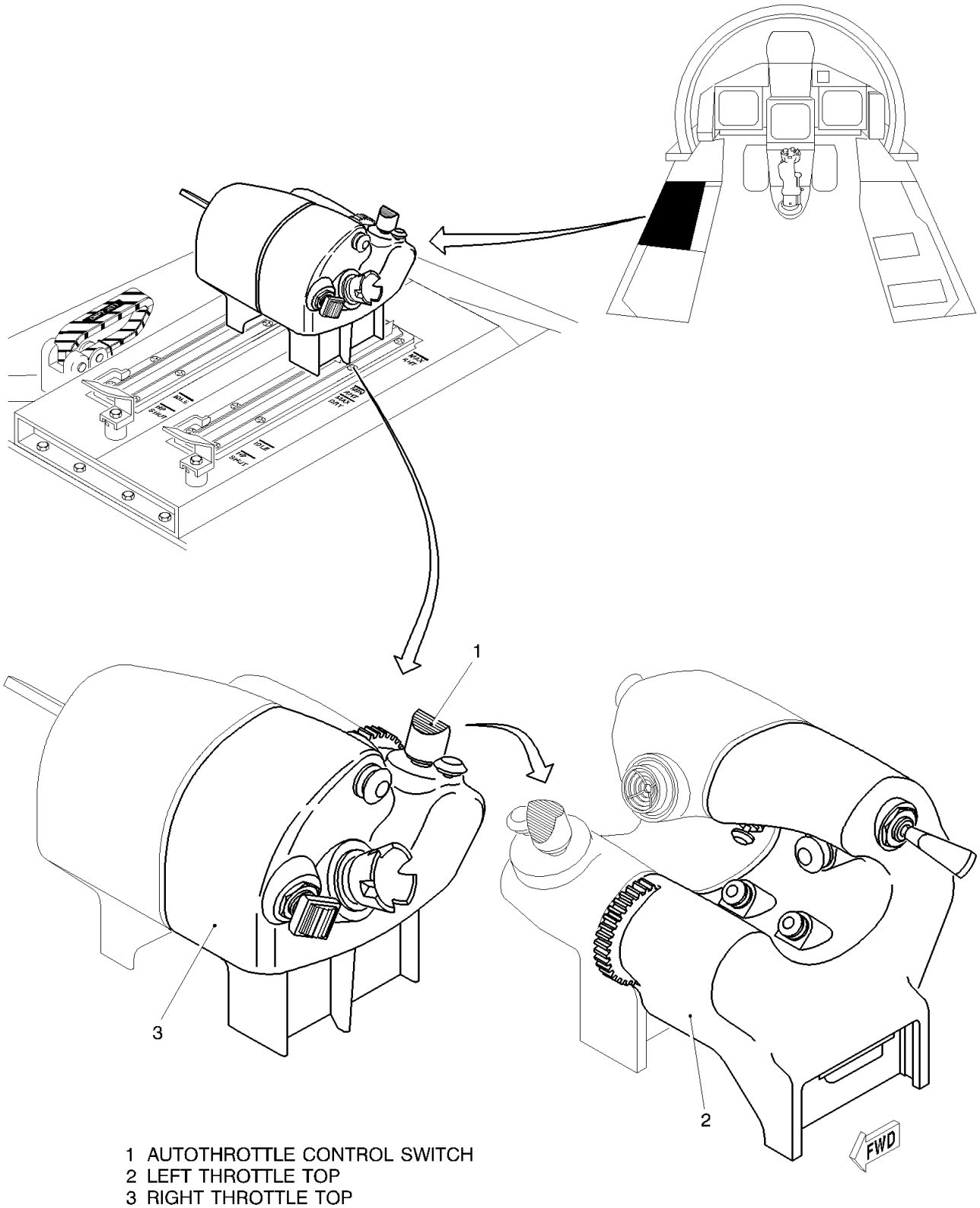


Figure 1.89 - Throttles

Engine Controls and Indicators

(1B-B-71-00-00-00A-111A-A Issue 004)

Engine control and monitoring is achieved by a combination of dedicated switches, controls and displays identically duplicated in front and rear cockpit (refer to Figure 1.90).

Engine information is displayed on the R MHDD by default on GND 2 and T/O PoF only.

The engine format (ENG) can be selected by pressing the ENG soft key (SK). The following engine information is shown:

– NL (low pressure turbine speed - percentage value)
– NH (high pressure turbine speed - percentage value)
– TBT (high pressure turbine blade temperature – Celsius degree)
– AJ (nozzle area - percentage value)
– FF (engine fuel flow)
– DECU lane in use (1 or 2, selectable by soft key)
– Left and Right Intake
– Engine warning captions.

Left and Right LP COCK switches

Fuel flows to each engine through a low pressure (LP) cock.

Two-position coverguarded bi-stable toggle switches labelled “L LP COCK” and “R LP COCK” are located in the left and right consoles respectively, with the following positions:

OPEN (guarded): L/R LP COCKs are opened and engine igniter circuits are enabled

SHUT (guard up): L/R LP COCKS are closed and engine igniter circuits are disabled.

Both L/R LP COCKs switches located in front and rear cockpits shall be set to OPEN to enable the igniter circuit.

Throttles

The throttles, located in the left console, control the engines from HP SHUT (high pressure fuel shut off is closed, so that the engine is in a shut down condition) to MAX RHT (maximum reheat operation enabled), passing through IDLE, MAX DRY and MIN RHT positions.

The pilot's throttle demand to the respective engine is made by moving the throttle lever with a linear movement (forward and aft). The left and right levers can be moved independently or simultaneously throughout their selectable ranges.

Dedicated warning panel (DWP)

The DWP shows all the MHDD warning captions.

The warning captions shown on the DWP when operating in normal mode are the following:

L DECU or **R DECU** DECU failure

L VIBR or **R VIBR** engine vibration

L OIL T or **R OIL T** engine oil overtemperature

L RHEAT or **R RHEAT** reheat failure

L RHEAT or **R RHEAT** reheat failure

L FLAME or **R FLAME** engine flame-out

L OIL P or **R OIL P** engine oil pressure low

L ENG P or **R ENG P** reduced engine performance

L FIRE or **R FIRE** engine fire

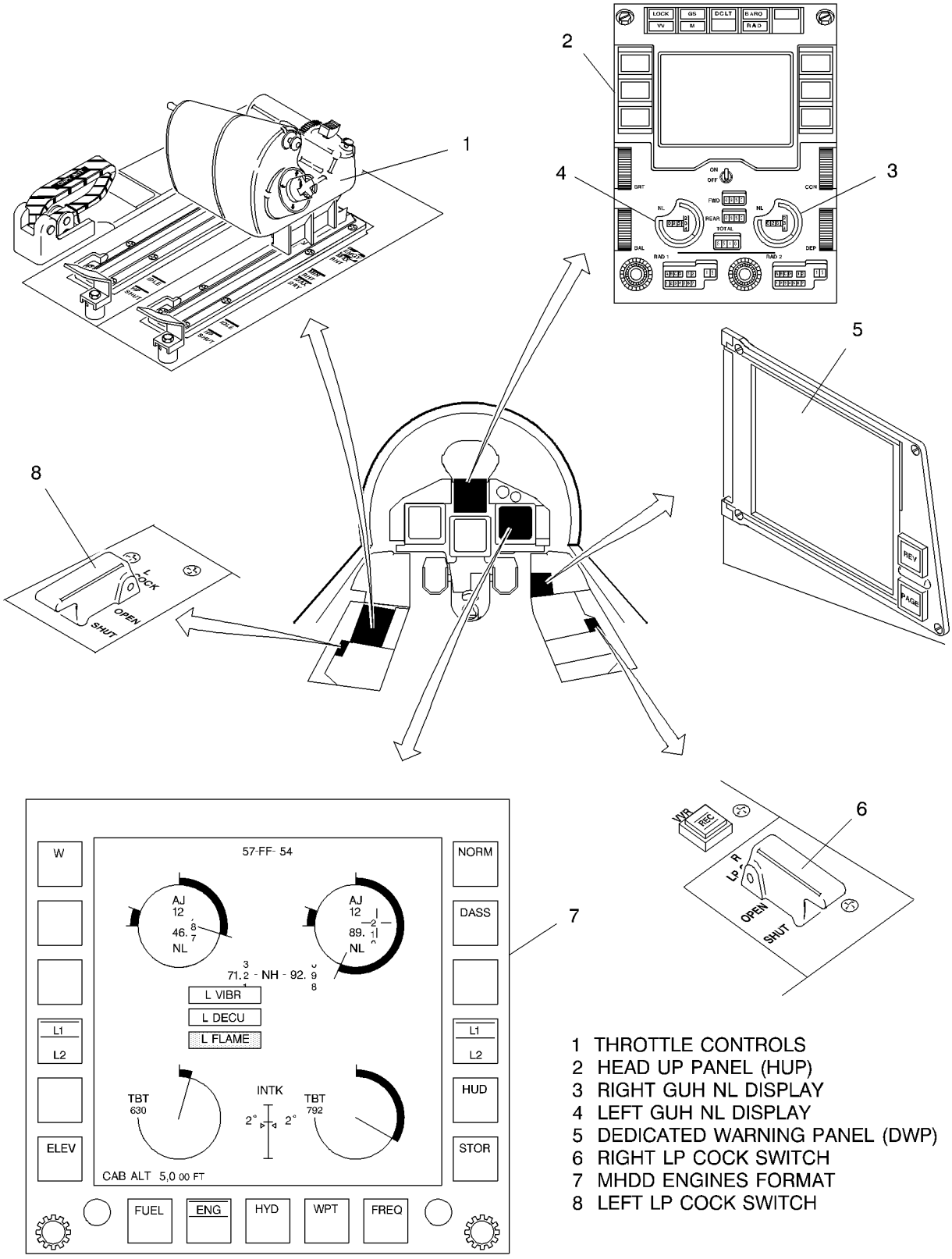
L COWL or **R COWL** intake cowl system failure during GND and T/O phase of flight

L COWL or **R COWL** intake cowl system failure during AA, NAV and LDG phase of flight.

When operating in reversionary mode only: **L FIRE** and **R FIRE** warning captions are shown.

Head Up panel (HUP)

The left and right engines NL (RPM %) values are shown in digital and analog form on the HUP.



1 THROTTLE CONTROLS
2 HEAD UP PANEL (HUP)
3 RIGHT GUH NL DISPLAY
4 LEFT GUH NL DISPLAY
5 DEDICATED WARNING PANEL (DWP)
6 RIGHT LP COCK SWITCH
7 MHDD ENGINES FORMAT
8 LEFT LP COCK SWITCH

Figure 1.90 - Engine Controls and Indicators — General layout

SECONDARY POWER SYSTEM

Secondary Power System

(1B-B-49-90-00-00A-043A-A Issue 009)

General

The major components of Secondary Power System (SPS) are:

- An Auxiliary Power Unit and its Control Unit (APUCU)
- Two gearboxes (G/B)
- Two Air turbine Starter Motors (ATS/M) and their respective, Control Valves (ATS/M CV)
- Two SPS computers part of the Utilities Control System (UCS).

Refer to Figure 1.91

The purpose of the SPS is to generate and use pneumatic power for engine starting and to supply hydraulic and electric power to aircraft systems during ground operation. It also provides the necessary Built In Test (BIT) information for maintenance and health monitoring purposes to the SPS computers and UCS.

Each gearbox drives a Constant Frequency Generator (CFG), a DC generator and a hydraulic pump.

The gearbox can be driven by its associated engine, or by its ATS/M. In the latter case, the necessary high pressure air can be provided either by the APU, by an external pneumatic source (e.g. Jet Air Starter) or by the other engine.

The SPS operates under active and passive control of UCS-SPS computers with the exception of the APU which is independently controlled by its Control Unit (APUCU).

During normal in-flight operations the UCS-SPS computers operate passively to:

- monitor the usage and condition of the SPS components
- monitor the condition of the engines and gearboxes, and initiate cross bleed mode when required
- inhibit APU operation
- detect hot air leakage from the SPS piping.

SPS Modes of Operation

The SPS has the following modes of operation:

- Ground operation
- Main engine starting
- Mission mode.

Ground Operation

This mode of operation (refer to Figure 1.92) comprises:

- non-autonomous operation
- autonomous operation
- Alert (Stand-by).

Non-Autonomous Operation

An external ground air source is used to drive the accessory gearboxes via their respective ATS/M for electrical and hydraulic system checks.

Autonomous Operation

Air from the APU drives one accessory gearbox via the applicable ATS/M for electrical and hydraulic power for system checks or both accessory gearboxes via the ATS/M's for hydraulic power for system checks. The APU also drives its generator to provide electrical power. Turn around or alert support can be sustained for at least 2 hours in this mode.

The APU is normally run with the canopy closed and the Environmental Control System (ECS) switch set to ECS. During the starting sequence of the first engine, the ECS is automatically commanded to shutdown (ECS PRSOV closed) and the Molecular Sieve Oxygen Concentrator Pressure Reducing Shutoff Valve (MSOC PRSOV) is commanded to open, bringing the Molecular Sieve Oxygen Generation System (MSOGS) into operation mode.

Alert (Stand-by)

NOTE

Before initiating the system test mode, the ECS switch must be set to OFF then RSET.

Simultaneous motoring of both gearboxes is possible from the APU, provided that the aircraft hydraulic power requests are minimized and both electrical generators are excluded. This allows the Flight Control System (FCS) to enter its NORMAL mode. The FCS remains in this mode even following the run down of one gearbox.

The APU supplies high pressure air to the ATS/M to drive the gearbox, providing hydraulic and electrical power for autonomous ground testing of aircraft systems.

Main Engine Starting

The main procedures for on-ground engine starts are essentially the same whether using an external air source or the APU (refer to Figure 1.93). The engine

is started by moving the throttle from the HP SHUT to the IDLE position. Automatic sequential starting (LH engine first) can also be performed by moving both throttles to IDLE .

During engine starting, the ATS/M drives its gearbox to accelerate the engine up to a cutout speed of 58 ÷ 63 % NH dependent upon the scheduled idle speed of the engine.

The engine starting modes may be arranged in two groups:

– Normal engine start
– Alternative engine start.

Normal Engine Start

Engine Starting Performance

At ISA +15°C (Sea Level), starting of the APU and both engines is normally achieved within 90 seconds after initiating the APU start sequence.

Engine starts under the worst environmental conditions (i.e. lowest allowed temperature) should not take longer than 3 minutes from APU start.

Autonomous Engine Start

Autonomous engine starting uses air supplied by the APU to drive the ATS/M. The front computer controls the appropriate ECS valves while the ATS/M CV regulates the flow of pressurized air to the ATS/M.

The ATS/M speed is controlled by the SPS computer via the ATS/M CV that is driven in current. The Aircraft Mounted Accessory Drive (AMAD) gearbox dog clutch is controlled by the SPS computer which also monitor all the other parameter.

With the APU running, automatic sequential engine starting (LH engine first) is performed by moving both throttles from the HP SHUT to the IDLE position at the same time. The ATS/M then drives the gearbox to accelerate the engine up to 58 ÷ 63 % NH.

On setting the throttles to IDLE:

– the DECUs are energized
– the SPS computer recognizes the APU as the air source
– when the SPS computer detects that the ATS/M has reached the cut out speed (58 to 63% NH depending on the scheduled IDLE), it commands the closure of the ATS/M CV.

The engine start cycle terminates when the scheduled IDLE speed is achieved.

CAUTION

ANOMALIES SUCH AS IGNITION FAILURE, FLAMEOUT, ENGINE FIRE ETC. MAY OCCUR DURING A START. IN THIS CASE ABORT THE START SEQUENCE BY RETARDING THE THROTTLES TO THE HP SHUT POSITION AND PLACE THE LP COCK SWITCHES TO THE SHUT POSITION.

During a start sequence, the ECS is isolate to give priority to starting. When the start sequence ends, the SPS computer commands the PRSOV to close. Simultaneously, the front computer commands the Variable Pressure Reducing Shut-Off Valve (VPRSOV) to open and the MSOC PRSOV to close thus recovering the ECS airflow.

Alternative Engine Start

Engine Start with External Ground Cart

The SPS computers recognize that the external pneumatic ground cart is the source of the pneumatic power when the APU is no run and the SPS piping is pressurized.

Assisted start (Alternative - A/C stationary)

An assisted start procedure assumes that the APU is already shut down, the aircraft wheel speed is less than 10 KDAS (5 m/s) and the AIR DRIVE switch momentarily to AUTO. It is recommended that the donor engine speed is at least 80% NH (65% NL). Engine start is assured in all operative environmental conditions.

Moving the throttle of the startup engine to IDLE requests the SPS computer to:

– detect the engine starting request
– ascertain the status of the APU (running or not)
– check the air pipe pressure (pressure or no pressure)
– check the status of the other engine (running or not).

If the result of the check is:

– APU not running
– no pressure in the SPS piping
– opposite engine running.

the SPS computers command the SPS PRSOV to open, while the front computer closes the ECS PRSOV and opens the MSOC PRSOV.

Assisted Start (Alternative - A/C taxiing)

After the first engine has started, the pilot can either:

– shut down the APU and begin to taxi
– begin the taxi with the APU running.

When the A/C wheel speed exceeds 10 KDAS the APU (if still running) is shut down by the SPS computers which, at the same time, automatically initiates the cross-bleed.
Setting the second engine throttle to IDLE and the AIR DRIVE switch momentarily to EMGY, cancels the cross-bleed and connects the gearbox mechanically to the second engine, which is then driven up to the gearbox cutout speed.

WARNING

THE ENGINE ASSISTED RELIGHT DURING TAXIING MUST BE AVOIDED.

The assisted relight during taxiing (aircraft wheel speed more than 10 KDAS) is not recommended because the cross-bleed running must be shut down to synchronize the AMAD gearbox and engine speed. This means that the related utilities (i.e. L/R GEN, L/R CONT P, L/R UTIL P, L/R COWL, NWS, A BRAKE) can be loosen following to the assisted relight request.

Mission Mode

Mission Mode (Normal Operation)

Each engine mechanically drives its own accessory gearbox to provide hydraulic and electrical power.

Mission Mode (Failure Operation)

Refer to Figure 1.94.
The SPS computers will detect the following failures:

– loss of mechanical drive, i.e. the LH/RH gearbox speed is lower than the speed of its engine. This condition means that engine is running normally but a gearbox or POT shaft failure has occurred
– engine flameout: the LH/RH engine speed is lower than idle.

In both cases, if the AIR DRIVE switch is in the AUTO position, the relevant SPS computer automatically recovers the failure by initiating the cross-bleed procedure, gearbox driven by ATS/M, which is supplied by engine bleed air.

NOTE

If necessary, the pilot can try to activate the cross-bleed by pressing the L/R GBOX push button.

During cross-bleed, the gearbox is driven at a constant speed by the ATS/M.
The SPS computer controls the speed of the Gearbox-ATS/M combination at 60% NH. If available bleed air is not enough to sustain 60% NH, the control speed drops to 45% NH. It is possible to recover 60% NH by setting the donor engine to at least 85% NH.

Cross-bleed operation description - Loss of mechanical drive case

When the L/R SPS computer detects the gearbox speed lower than engine speed -10% NPOT, it declares a loss of mechanical drive from engine to accessories (hydraulic pump, generators). As consequence the cross-bleed is confirmed and the L/R POT amber caption is generated on DWP, the attention getting flashing and the voice warning “LEFT/RIGHT POWER TAKE OFF” is given in the headset. In parallel a “L/R X-BLEED” message is displayed on MHDD and the front computer is advised.
Cross-bleed operation will continue in different ways, depending on the kind of failure, POT shaft failure or gearbox failure, that is the cause of loss of mechanical drive.

– In case of POT shaft failure the ATS/M accelerates the gearbox up to 60% NPOT speed.
– In case of gearbox failure and POT rupture:
  • The L/R POT amber warning caption is immediately generated on DWP, the gearbox speed drops suddenly and the ATS/M is commanded to accelerate as above, but the very high resistant torque due to gearbox seizure does not allow the ATS/M to accelerate the gearbox up to the 60% NPOT speed.
  • If the SPS computer detects an ATS/M under speed less than 20%, the cross bleed operation is interrupted after 20 s. The L/R GBOX red warning caption is also triggered on DWP, the attention getting flashing and the voice warning “RIGHT/LEFT GEARBOX” is also given in the headset.

Cross-bleed operation description - Engine flameout case

When the SPS computer detects the engine speed below idle –5% NPOT, and the gearbox speed is

below 80% NPOT, it considers this as an engine flameout and starts cross-bleed. The ATS/M initially accelerates with a rate of 10000 rpm/s reducing to 1000 rpm/s when the ATS/M speed reaches 50% NPOT or the limiting AMAD gearbox speed –10% NPOT, whichever occurs first.

There are two possible cross-bleed conditions. These depend upon the engagement speed:

– If the ATS/M reaches 60% NPOT while the AMAD gearbox speed is still above this value, the SPS computer controls the ATS/M speed at 60% NPOT. When the gearbox speed reaches 60% NPOT, the ATS/M - gearbox freewheel is automatically engaged.

  At the same time the engine runs down autonomously to its windmilling speed.

  This also occurs if the gearbox push-button is pressed before a deliberate engine shutdown and the interval between pressing the gearbox push-button and shutting the throttle is less than 45 seconds.

– If the engagement between the ATS/M and the AMAD gearbox occurs below 52-55% NPOT, the AC and DC electrical generators go transiently off line and the relevant left or right GEN amber warning caption could appear on DWP.

Assisted Relight In Flight

CAUTION

BEFORE INITIATING AN ASSISTED RELIGHT, VERIFY THAT THE HYDRAULIC PUMP ON THE OTHER POWER CHANNEL IS NOT DEPRESSURIZED TO AVOID TRANSIENT LOSS OF HYDRAULIC POWER.

A flameout or shutdown in flight will automatically activate HP cross-bleed air from the live engine to drive the AMAD gearbox of the flamed-out engine.

During an assisted relight in flight the following warning captions could temporarily appear on DWP:

– **L GEN** or **R GEN**

– **L CONT P** or **R CONT P**

– **L UTIL P** or **R UTIL P**

– **L COWL** or **L COWL**

Windmilling Relight

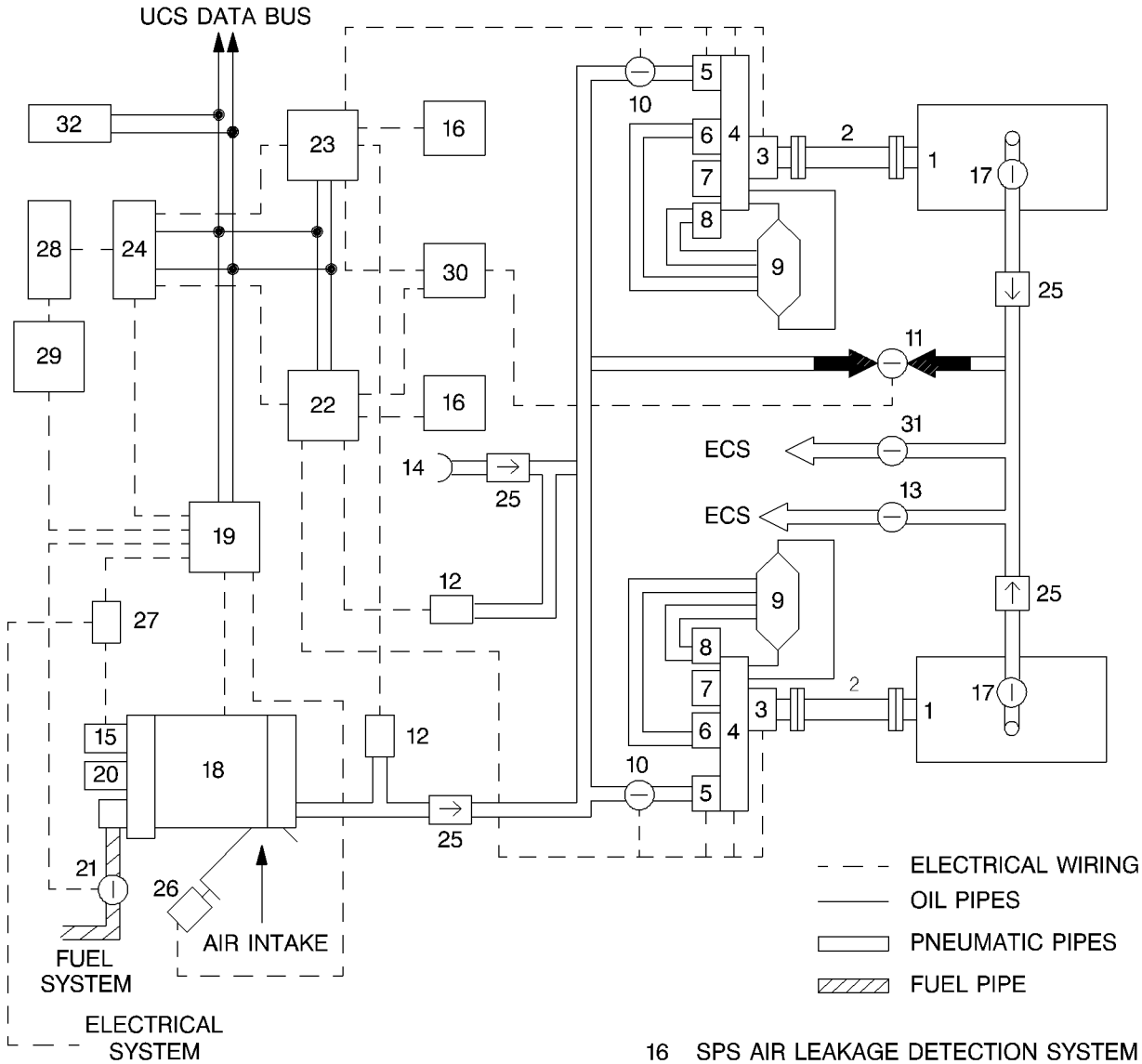
During windmilling relight, if the throttle is set to IDLE or above, auto-ignition is effected under DECU control.

Restart after a Failed Engine Start

Following a failed engine start, a restart can be attempted by moving the throttle to the HP SHUT position and then resetting it to IDLE.

SPS Air Leakage Detection

In both ground and flight conditions, each SPS computer is fed with eight temperature inputs from sensors located at the junctions of the SPS air pipe. These inputs are compared against a threshold value, and if any value exceeds 250° C in flight, the SPS LEAK red caption illuminates on the DWP. On the ground, the threshold value is 150° C.
If the APU is currently running when a leak is detected, the SPS computer also sends a stop signal to shut it down.
In the event of a major hot air leakage in flight, it is recommended to interrupt cross bleed. If the warning does not disappear land ASAP.
The only exception to this is with other concurrent failures such as a damaged gearbox or a hydraulic failure on the good engine side. Here, the cross bleed must be continued but the engine setting must be reduced (compatible with flight conditions) to maintain cross bleed for the utilities, while keeping the hot gas outflow to the minimum possible before landing ASAP.



1 ENGINE
2 PTO SHAFT
3 FREE WHEEL/DOG CLUTCH
4 GEARBOX
5 AIR TURBINE STARTER MOTOR
6 CONSTANT FREQUENCY GENERATOR
7 DC GENERATOR
8 HYDRAULIC PUMP
9 FUEL COOLED OIL COOLER
10 ATS/M CONTROL AND SHUT-OFF VALVE
11 SPS PRSOV
12 SPS PRESSURE SENSOR
13 VARIABLE PRESSURE REDUCING AND SHUT-OFF VALVE
14 GROUND CONNECTION
15 APU STARTER
16 SPS AIR LEAKAGE DETECTION SYSTEM
17 ENGINE BLEED SOV (ECS)
18 APU
19 APU CONTROL UNIT
20 APU GENERATOR
21 FUEL SHUT-OFF VALVE
22 LEFT SPS COMPUTER (UCS)
23 RIGHT SPS COMPUTER (UCS)
24 COCKPIT CONTROLS AND INDICATORS
25 NON-RETURN VALVE
26 APU AIR INTAKE ACTUATOR
27 APU CONTACTOR
28 APU EXTERNAL START SWITCH
29 MDP BAY APU CONTROLS AND INDICATORS
30 SPS PRSOV CONTROL RELAY
31 MSOC PRSOV
32 DWP/MHDD INDICATIONS

Figure 1.91 - SPS General Configuration

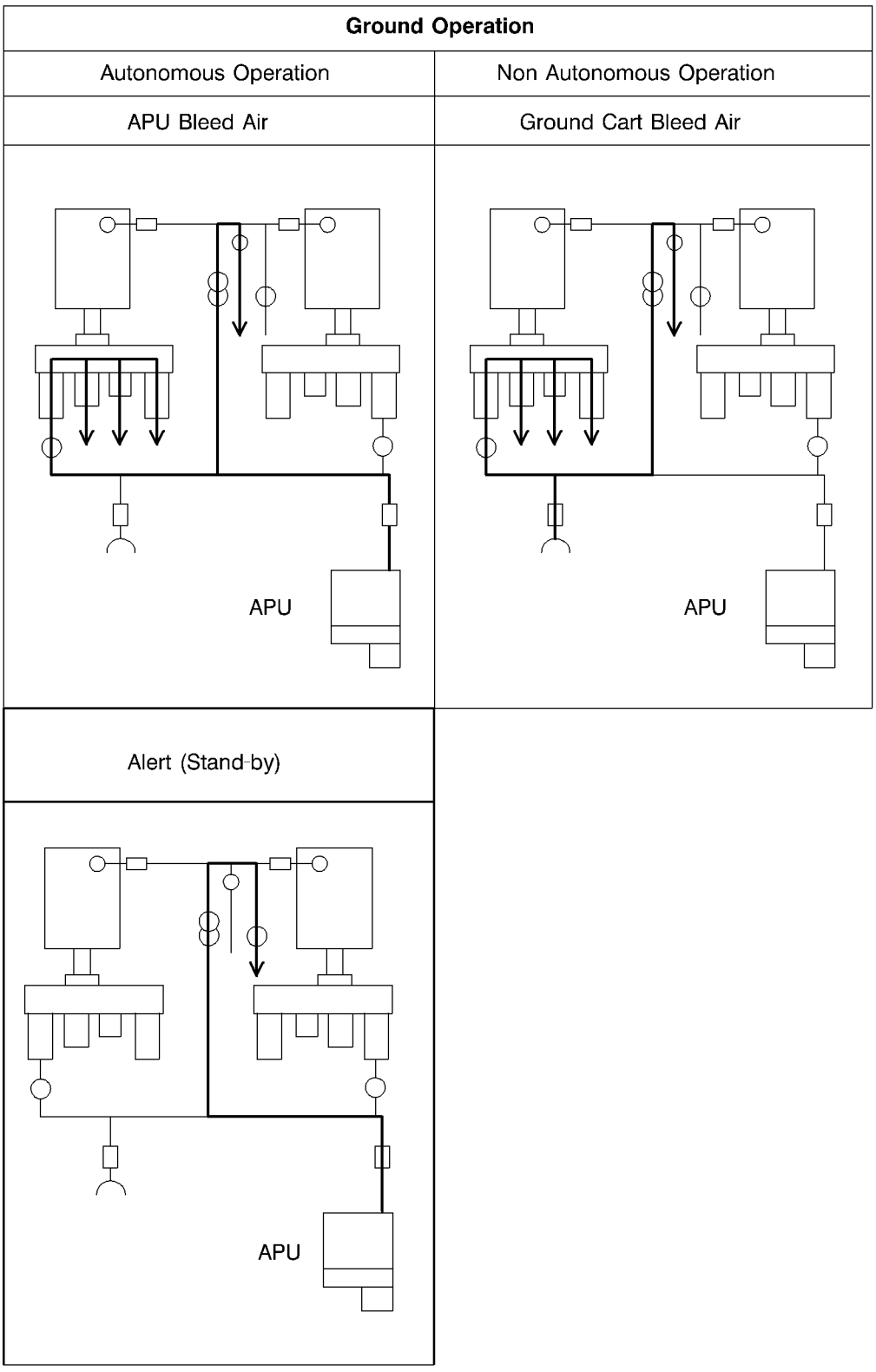


Figure 1.92 - Ground Operation

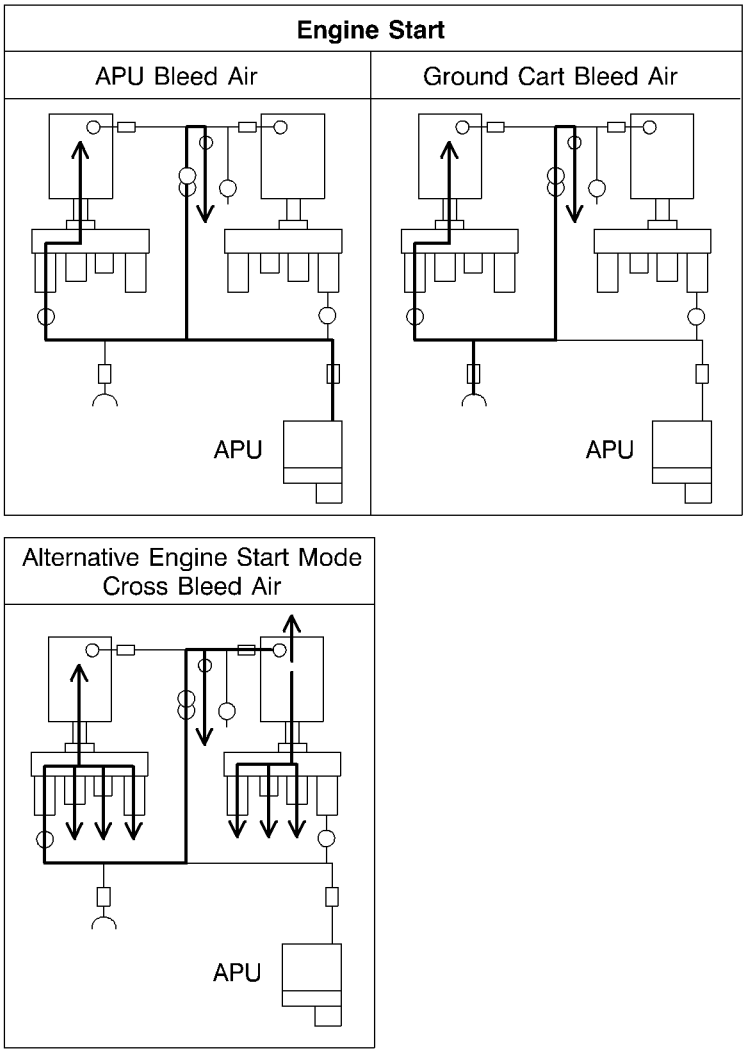


Figure 1.93 - Engine Start and Mission Mode

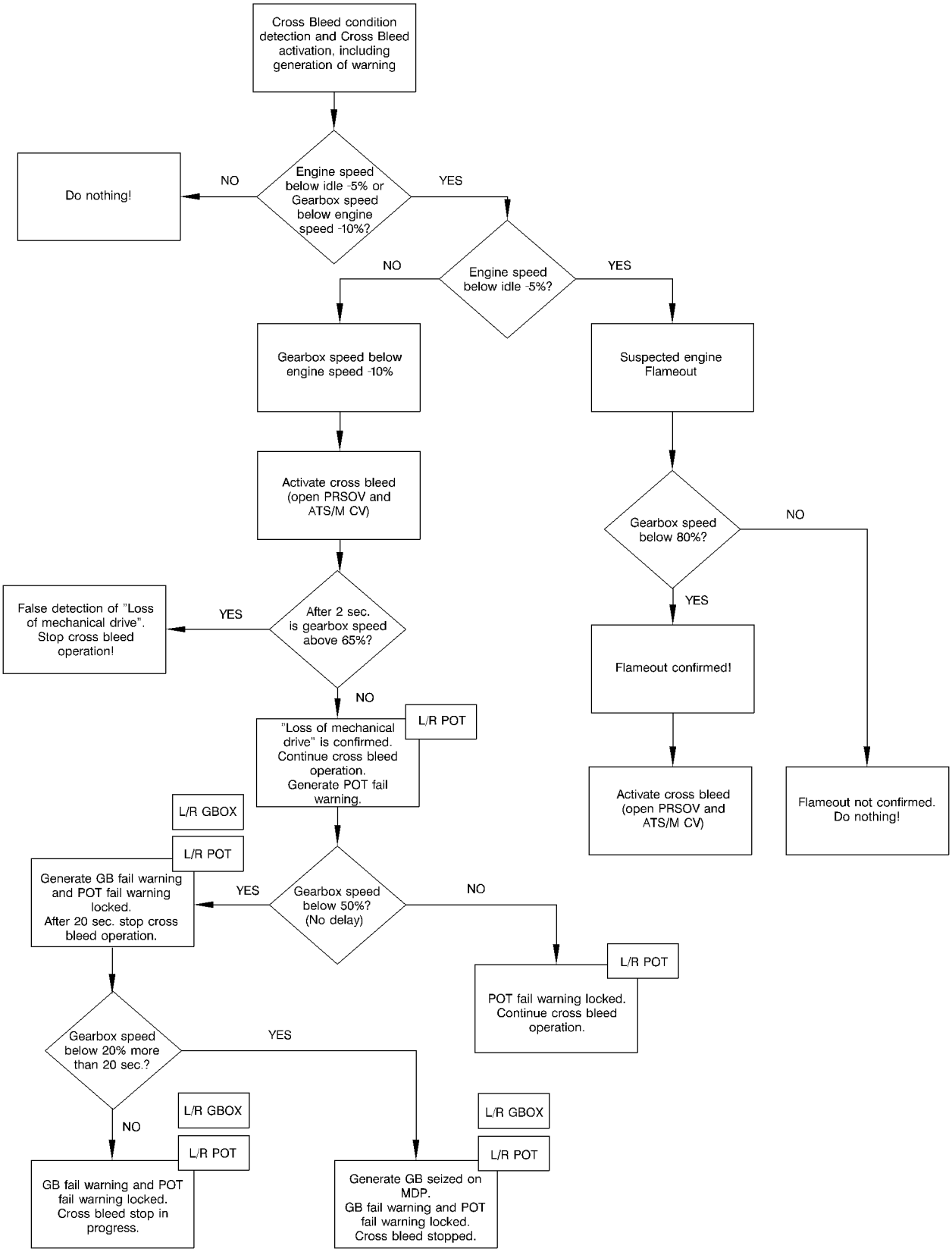

Cross Bleed condition detection and Cross Bleed activation, including generation of warning
Engine speed below idle -5% or Gearbox speed below engine speed -10%?
NO
Do nothing!
YES
Engine speed below idle -5%?
NO
YES
Gearbox speed below engine speed -10%
Suspected engine Flameout
Activate cross bleed (open PRSOV and ATS/M CV)
Gearbox speed below 80%?
NO
YES
Flameout confirmed!
Activate cross bleed (open PRSOV and ATS/M CV)
Flameout not confirmed. Do nothing!
After 2 sec. is gearbox speed above 65%?
YES
False detection of "Loss of mechanical drive". Stop cross bleed operation!
NO
"Loss of mechanical drive" is confirmed. Continue cross bleed operation. Generate POT fail warning.
L/R POT
L/R GBOX
L/R POT
Gearbox speed below 50%? (No delay)
YES
NO
Generate GB fail warning and POT fail warning locked. After 20 sec. stop cross bleed operation.
L/R POT
POT fail warning locked. Continue cross bleed operation.
Gearbox speed below 20% more than 20 sec.?
YES
NO
L/R GBOX
L/R POT
GB fail warning and POT fail warning locked. Cross bleed stop in progress.
L/R GBOX
L/R POT
Generate GB seized on MDP. GB fail warning and POT fail warning locked. Cross bleed stopped.

Figure 1.94 - Cross-bleed condition detection and activation

Auxiliary Power Unit

(1B-B-49-10-00-00A-043A-A Issue 005)

The APU allows the aircraft to operate independently from ground facilities. It provides compressed air and electrical power used for engine starting and cockpit conditioning.

The APU can also support an alert phase or a turn-around procedure by supplying pressure air to the ECS and the MSOGS as well as providing electrical power from its standby generator. The APU can be run in these conditions for up to 2 hours.

The APU is located in a bay present in the left wing root, forward the main landing gear. It draws its air through an intake door in the bay itself and ducts its exhaust gases overboard through an outlet in the upper fuselage/wing fairing.

The APU consists of the following basic elements:

– power section
– gearbox
– lubricating system
– fuel system
– control unit (APUCU)
– exhaust duct.

Power Section

The power section consists of a centrifugal compressor, a reverse flow annular combustor and a radial inflow turbine.

Gearbox

The gearbox provides a mounting pad for all the APU accessories (fuel control unit, electrical starter motor, oil pump) and for the AC generator. It first transfers torque from the starter motor to the compressor and turbine assembly during starting phase, then to the AC generator and all the accessories during steady-state operation.

Lubricating System

The lubricating system is an integral part of the APU. The APU is capable to operate without oil for a maximum of 30 seconds without being damaged. In case of oil flow interruption, the APUCU will shut down the APU automatically.

Fuel System

The APU self-contained fuel system provides metered fuel flow, gravity fed from the aircraft fuel system via a dedicated shut-off valve and a manifold tee, to the nozzles assemblies for APU operation within scheduled limits, proportionally with the inputs received from the APUCU.

Control Unit

The APU is automatically controlled and protected, under all operational conditions by a full authority digital electronic control unit (APUCU). This unit is installed in an unconditioned bay close to the APU but separate by a fire wall.
The APUCU provides the following main control and monitoring function:

– self-initiated built-in test (BIT)
– APU air intake door actuation
– APU starting throughout all its operating envelope
– monitoring of the APU parameters and APU components during steady-state operation
– shut down if danger conditions for personnel and / or APU occur (overspeed / overtemperature).

The APUCU is also interfaced with secondary power system (SPS) computers, UCS front computer and maintenance data acquisition system by means of the UCS dual redundant data bus for the exchange of status, inhibit, maintenance and health monitoring signals.

Exhaust Duct

The exhaust duct is a stainless steel pipe and it dumps exhaust gases overboard and it is thermally insulated to limit the skin temperature.

APU Operation

(1B-B-49-40-00-00A-043A-A Issue 004)

GENERAL

The APU operation can be divided into the following phases:

– starting
– steady-state
– shut-down.

STARTING

Normal Operation

NOTE

The external electrical power supply must be used for APU starting below – 25°C.

The starting procedure can be initiated placing the START/STOP switch, located on the right console, or the external start switch, present in the left wing

root leading edge, to START provided that the BATT switch is set to ON.
As a consequence, the following actions will be performed by the APUCU:

– identification of the electrical power supply (A/C battery or external ground supply)
– BIT procedure
– integrity check of all the APU temperature, pressure and speed sensors
– opening of the APU fuel SOV
– opening of the APU intake door
– control of the ignition, fuel and speed control systems.

From the starting input up to the 95% of the nominal APU speed, the APU caption of the status indicator will be illuminated.
The APU reaches its stabilized speed at 100% of the nominal speed within 30 seconds at ISA and ISA + 15° SL. During this time the APU is continuously monitored by the SPS computers via UCS data bus.

Failure Case Operation

The APU starting phase is automatically interrupted and the shut-down procedure is initiated in case of abnormal conditions (e.g. electrical power interruption, starting time exceeded, hot air leakage) or if sensor failures, which could lead to APU incorrect operation, are detected by the APUCU.
If the starting is aborted, it is possible to repeat the procedure providing that the APU nominal speed is less than 10% of the nominal speed otherwise the starting input will be ignored.
After three start attempts, a further starting action is inhibited by the APUCU and it is necessary to perform a maintenance action and to reset the APUCU itself.

STEADY-STATE OPERATION

Normal Operation

At the end of the starting phase, the APU runs at its nominal speed. The APU caption and the peripheral box of the APU status indicator will be illuminated. The APUCU receives signals from the SPS computers and the front computer indicating which operating mode is required:

– Engine starting. The APU is required to operate at full load in order to supply compressed air to the ATS/M and to drive the APU generator.
– Gearbox motoring. The APU is required to operate at a variable load depending on the power level required by both A/C hydraulic and electrical systems. Mechanical power to the APU generator is also supplied.
– Stand-by. The APU is required to operate a variable load depending on ECS request. Mechanical power to the APU generator is also supplied.

Failure Case Operation

The steady-state operation is interrupted and the shut down procedure initiated in case of abnormal conditions and/or when sensor failures are detected by the APUCU or if the APU run speed drops below 90% of the nominal value.

SHUT-DOWN

Normal Operation

The shut-down procedure initiates when one of the following conditions occurs:

– the pilot places the APU switch to STOP
– the ground crew places the three position switch in the MDP bay to STOP/INHIBIT
– the APUCU receives a stop request signal from SPS computers (via UCS data bus) when both engines are running or the A/C weight is not detected on wheels or the A/C speed is higher than 5 m/s or an ATS/M overspeed has been detected
– the APUCU receives a hardwired signal from the fire detection system indicating an overtemperature in the APU bay
– the APUCU receives a signal from the SPS computers (via UCS data bus) indicating an hot air leakage in the APU bay

The APUCU will inhibit both the APU cockpit and external START/STOP switches in the last three cases
As a consequence, the following actions will be performed by the APUCU:

– it depowers the APU caption of the APU status indicator
– upon receiving all "closed position" signals (e.g. APU fuel shut-off valve, APU intake door) or 30 seconds after the shut down input has been received, the peripheral box of the APU status indicator will be occulted
– it commands the air intake door to close. In case the door is not detected in close position, the caption APU DOOR is displayed on the DWP accompanied by the “APU DOOR” audio voice message. After the APUCU deenergization, it is necessary to monitor the air intake door to avoid any hazard due to the door being in open position which can happen during extreme manoeuvres of aircraft. The actuator intake position is continuously monitored in parallel to the APUCU by the RH SPS computer leaving the actuation to the APUCU only. The intake door will be maintained open for about one

minute after shut-down to allow the cooling of the APU bay.

Failure Case Operation

The APU shut-down procedure will not be interrupted in any failure case.

APU Inhibition

The APU operation is inhibited by the two SPS computers and the APUCU when one of the following conditions occurs:

– both engines are running
– SPS system failure (ATS/M overspeed)
– A/C speed higher than a 5 m/s
– A/C weight not detected on wheels.

Therefore the APU shutdown sequence (if the APU is running) will be initiated and the START switch in the cockpit will be inhibited.

SPS

(1B-B-49-90-00-00A-111A-A Issue 006)

The SPS controls and indicators (refer to Figure 1.95) consists of:

– SPS controls
– voice warnings
– SPS warning indicators.

SPS Controls

APU START/STOP Switch

The switch is installed on front cockpit right console only.
This is a three-position toggle switch (START/ neutral/STOP), spring-loaded to the center (neutral) position.

– START Position: The APUCU is cued to initiate the APU starting sequence, including APUCU power-up BIT and operation of APUCU controlled equipment
– STOP Position: The APUCU is cued to initiate the APU shutdown sequence (including operation of APUCU controlled equipment). At the end of the sequence the APUCU shuts itself down
– Neutral Position: natural rest position. Has no effect on any previous selection.

AIR DRIVE Switch

This is a three-position toggle switch which is spring-loaded from the forward (EMGY) position to the center (AUTO) position where it locks. It must be unlocked prior to selecting it forward or to the aft (OFF) position.

It is also trip-locked in the OFF position and must be unlocked prior to selecting it forward again. This position is for ground maintenance purposes and to shutdown the cross-bleed in case of emergency procedure.
The positions and functions of the switch are:

– EMGY (Assisted Engine Relight)
– AUTO (Normal Ground/Flight position)
– OFF (Pneumatic drive not enabled).

NOTE

If the switch is not in the AUTO position, the indication AIR DRIVE appears on the MHDD/ENG format.

EMGY Position (Assisted engine relight)

In the event of an engine flame-out (with the AIR DRIVE switch in the AUTO position), cross bleed is automatically initiated using bleed air from the running engine.
The pilot initiates an assisted engine relight by placing the start-up engine throttle to IDLE then momentarily selecting the AIR DRIVE switch to EMGY.
Bleed air from the running engine drives the start-up engine up to IDLE speed via the ATS/M and the gearbox dog clutch engaged. The gearbox is now mechanically driven by its respective engine and normal flight condition has been reached. Then gearbox dog clutch is disengaged, the ATS/M-CV and PRSOV closed.
If relight is not successful, the previous cross-bleed condition is automatically restored.

NOTE

The SPS computer software does not allow an “assisted” relight when the A/C is on the ground and its speed is lower than 5 m/s (i.e. A/C considered as stationary). In this condition, placing the switch to EMGY has no effect.

AUTO Position (Normal Ground and Flight Position)

On Ground (A/C stationary only, i.e. speed lower than 5 m/s)

The AUTO position is mandatory to enable all operations involving the ATS/M, i.e. engine starting (throttle to IDLE, air supply from APU, ground cart or opposite engine) or gearbox motoring, which is commanded by the GBOX L/R pushbuttons.

In Flight (including A/C on ground with speed higher than 5 m/s)

The AUTO position is mandatory to enable the SPS computers to automatically initiate cross-bleed if either of the following events occurs:

– engine speed falls below the idle value (i.e. engine flame-out)
– gearbox speed falls below engine speed (i.e. loss of mechanical drive to the gearbox).

In the event of an engine flame-out, the gearbox of the affected engine is maintained at 60% speed by cross-bleed air from the running engine until the windmill relight procedure is successful.
Following a successful relight, normal flight condition (i.e. each gearbox mechanically driven by its respective engine) is restored.

OFF Position

WARNING

SELECTING THE AIR DRIVE SWITCH TO OFF DISABLES THE GEARBOX PNEUMATIC DRIVE WITH CONSEQUENT LOSS OF THE FOLLOWING SPS FUNCTIONS:

– ENGINE STARTING
– GEARBOX MOTORING
– CROSS-BLEED
– ASSISTED ENGINE RELIGHT.

When the AIR DRIVE switch is set to OFF, the SPS computer inhibits the ATS/M control valves by commanding them to maintain their closed position. The ATS/Ms are then unable to drive their respective gearboxes.
During ground procedures, this selection provides an additional means of protection for ground crew against inadvertent engine rotation, ignition or gearbox-ATS/M operation.

AIR DRIVE Switch (Rear Cockpit)

CAUTION

IF THE FRONT AND REAR AIR DRIVE SWITCHES ARE OPERATED AT THE SAME TIME, BUT WITH CONTRASTING SELECTIONS, THE SPS COMPUTER RESOLVES THE CONTRAST BY ASSIGNING THE PRIORITY TO THE COMMAND THAT ASSURES THE AIRCRAFT SAFETY.

The rear cockpit AIR DRIVE switch, located on the right console, is a two position toggle switch, spring-loaded from the forward (EMGY) position to the center (AUTO) position where it locks. The toggle must be lifted to unlock before a forward selection can be made. Unlike the front cockpit switch, the rear cockpit switch does not have an OFF position.
The switch can be set to one of two positions, whose effects are identical to those of the front cockpit:

– EMGY Position (Assisted Engine Relight)
– AUTO Position (Normal Condition).

Left/Right Gearbox Air Drive Pushbuttons (L/R GBOX)

Two momentary action pushbuttons (L/R GBOX) are located on front cockpit left console only.

NOTE

They are enabled only when the AIR DRIVE switch is in the AUTO position.

Pushing either button provides pneumatic power from any active source (i.e. APU, external air supply or opposite engine) to the appropriate ATS/M-gearbox.
This can be used:

– On the ground: for system checkout purposes (e.g. start/stop gearbox motoring).
– In flight: to reset the software routines which govern cross-bleed, thus restarting a cross-bleed operation which had terminated automatically.

Pushing the button a second time cancels the previously selected operation.

Voice warnings

The following voice warnings are provided:

– LEFT GEARBOX TEMP
– RIGHT GEARBOX TEMP
– SPS OVERPRESSURE
– LEFT POWER OFF TAKE
– RIGHT POWER OFF TAKE
– LEFT GEARBOX
– RIGHT GEARBOX
– APU DOOR
– LEFT AIR TURBINE
– RIGHT AIR TURBINE
– SPS LEAK

SPS WARNING INDICATORS

APU Status Indicator

APU status indications are provided as follows:

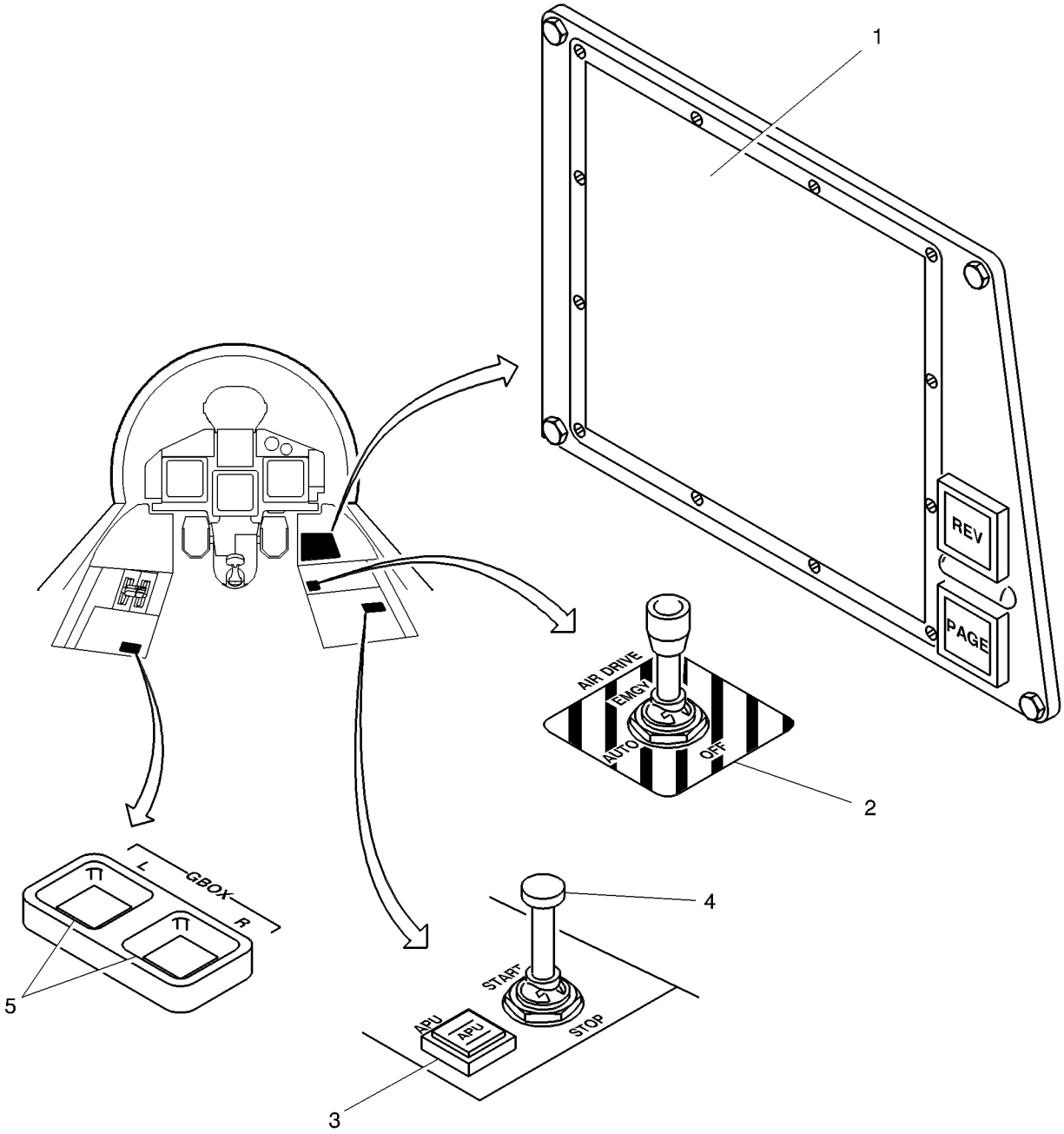
- During the APU starting phase (from generation of start input until 95% rpm is achieved), only the APU caption is lit.
- As soon as 95% is exceeded and during steady state operation, both the APU caption and its box are lit.
- As soon as the APU shut-down sequence is initiated, the APU caption is extinguished and only its box remains lit until the end of the APU shut-down sequence, when the APUCU also shuts down.

Multi-Function Head Down Display (MHDD)

- L GBOX: left gearbox motoring in progress boxed in red - not in progress boxed in green (MHDD/MNTC)
- R GBOX: right gearbox motoring in progress boxed in red - not in progress boxed in green (MHDD/MNTC)
- L XBLEED: left cross bleed in progress (MHDD/PA)
- R XBLEED: right cross bleed in progress (MHDD/PA)
- NO AUTO: air drive switch not in AUTO position (MHDD/PA).

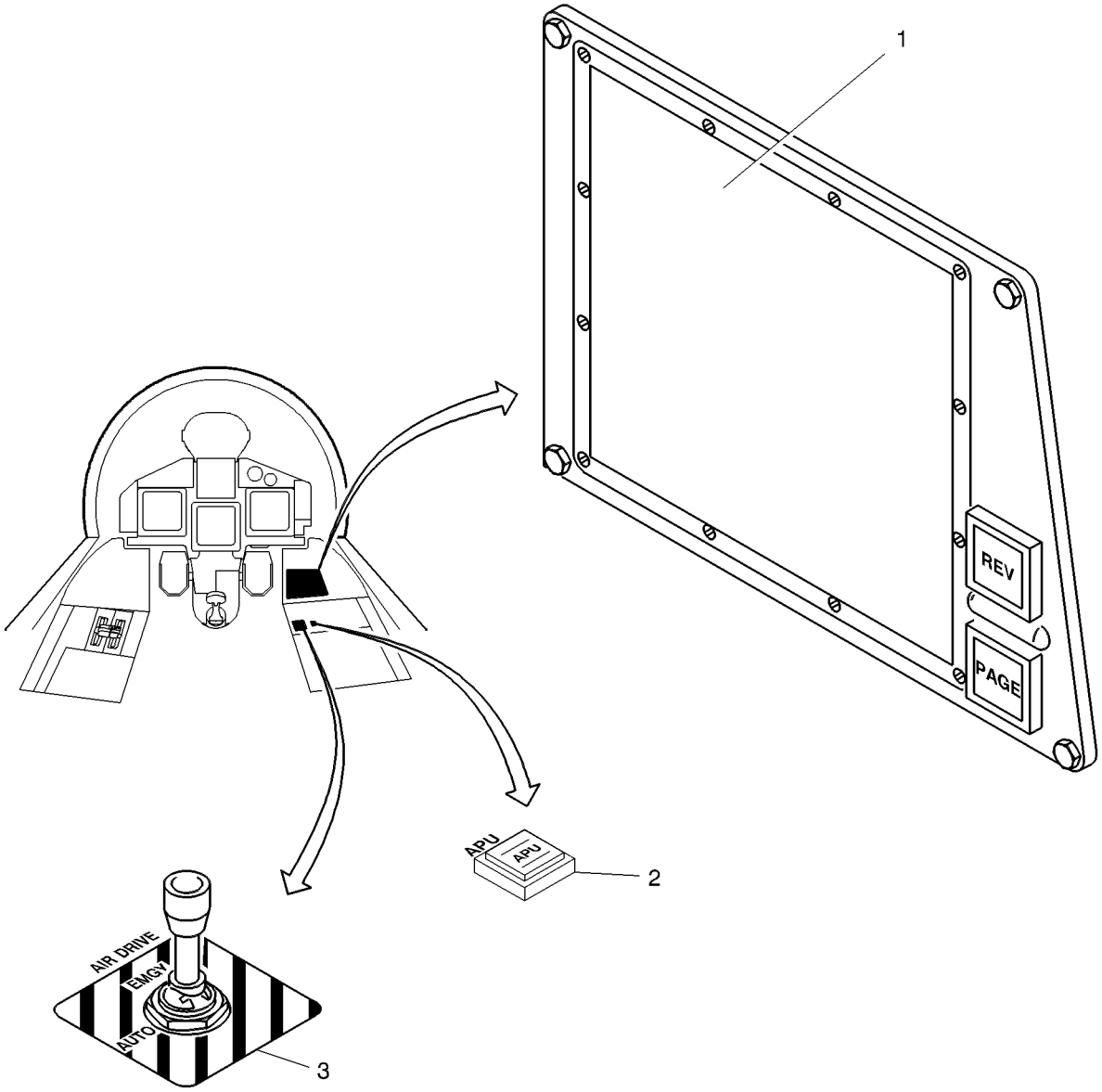
Dedicated Warning Panel

- **L POT** : left power off-take shaft failure (DWP normal mode)
- **R POT** : right power off-take shaft failure (DWP normal mode)
- **L GBOX** : left gearbox failure (DWP normal mode)
- **R GBOX** : right gearbox failure (DWP normal mode)
- **L GBOX T** : left oil overtemperature and/or oil low pressure (DWP normal mode)
- **R GBOX T** : right oil overtemperature and/or oil low pressure (DWP normal mode)
- **L ATSM** : left air turbine starter motor overspeed failure (DWP normal)
- **R ATSM** : right air turbine starter motor overspeed failure (DWP normal)
- **APU DOOR** : APU air intake door actuator failure (DWP normal mode)
- **SPS P** : piping air overpressure or NRV failure (DWP normal mode)
- **SPS LEAK** : piping hot air leakage (DWP normal mode)



1 DEDICATED WARNING PANEL (DWP)
2 AIR DRIVE SWITCH
3 APU STATUS INDICATOR
4 APU START/STOP SWITCH
5 LEFT/RIGHT GEARBOX AIR DRIVE PUSHBUTTON

Figure 1.95 - SPS Controls and Indicators



1 DEDICATED WARNING PANEL (DWP)
2 APU STATUS INDICATOR
3 AIR DRIVE SWITCH

Figure 1.96 - SPS Controls and Indicators (Rear Cockpit)

ENGINE/APU FIRE PROTECTION SYSTEM

Engine/APU Fire Protection System

(1B-B-26-10-00-00A-043A-A Issue 007)

The system provides a fast overheat/fire detection, both on ground and in flight, by means of seven continuous length pneumatic thermal detectors, located in the two engine bays and APU bay respectively. The detectors are installed as follows:

– three in each engine bay
– one in the APU bay.

The system is powered by the PP3 and battery busbar.

The warning signals from the engines fire detectors are sent, via SPS computer, to the DWP (normal mode), to the CAMU and to the MHDD/ENG format.

The same signals are sent directly to the two fire indicators/pushbuttons and to the DWP when operating in REV mode.

The warning signal from the APU fire detector is sent directly to the APU control unit and to the DWP when operating in REV mode. The warning signal is also sent, via SPS computer, to the DWP (normal mode) and CAMU.

The warning signal is cleared as soon as the detected temperature decreases below the trigger level.

Fire Extinguisher System

The system is designed to extinguish fires in the engine bays by means of a single bottle containing CF3Br (Bromotrifluoromethane) extinguishing agent, and located in the "V" bay between the two engines.

Two electrically detonated firing cartridges are commanded by the two fire indicator/pushbuttons. Detonation of the relevant explosive cartridge enables the entire contents of the bottle to be discharged into the affected engine bay.

Fire Detection System Controls and Indicators

The fire detection system controls and indicators (refer to Figure 1.97) consist of:

– fire warning indications
– voice warnings
– fire indicators / pushbuttons.

They are identically duplicated in the rear cockpit.

Fire Warning Indications

The following warning indications are displayed to indicate the APU/Engines fire conditions:

L FIRE Fire or overheating in the left engine bay. Shown on MHDD/ENG format and DWP (normal and reversionary mode)

R FIRE Fire or overheating in the right engine bay. Shown on MHDD/ENG format and DWP (normal and reversionary mode)

APU FIRE Fire or overheating in APU bay. Shown on DWP (normal and reversionary mode).

During the APU starting phase, if electrical power is not available (BATT OFF), the DWP warning indication, the flashing attention getters, the attention sounds as well as the voice message are not available.

In this case, an APU fire warning is given by the canopy audio horn with a modulated tone. The tone is modulated to avoid confusion with the normal audio warning which occurs during canopy operations. As soon as electrical power becomes available, all APU fire warnings become functional and the modulated signal to the canopy horn is inhibited.

NOTE

Both the modulated and the normal canopy horn are inhibited during flight.

Voice Warnings

The following voice warnings are provided:

– left engine fire
– right engine fire
– APU fire.

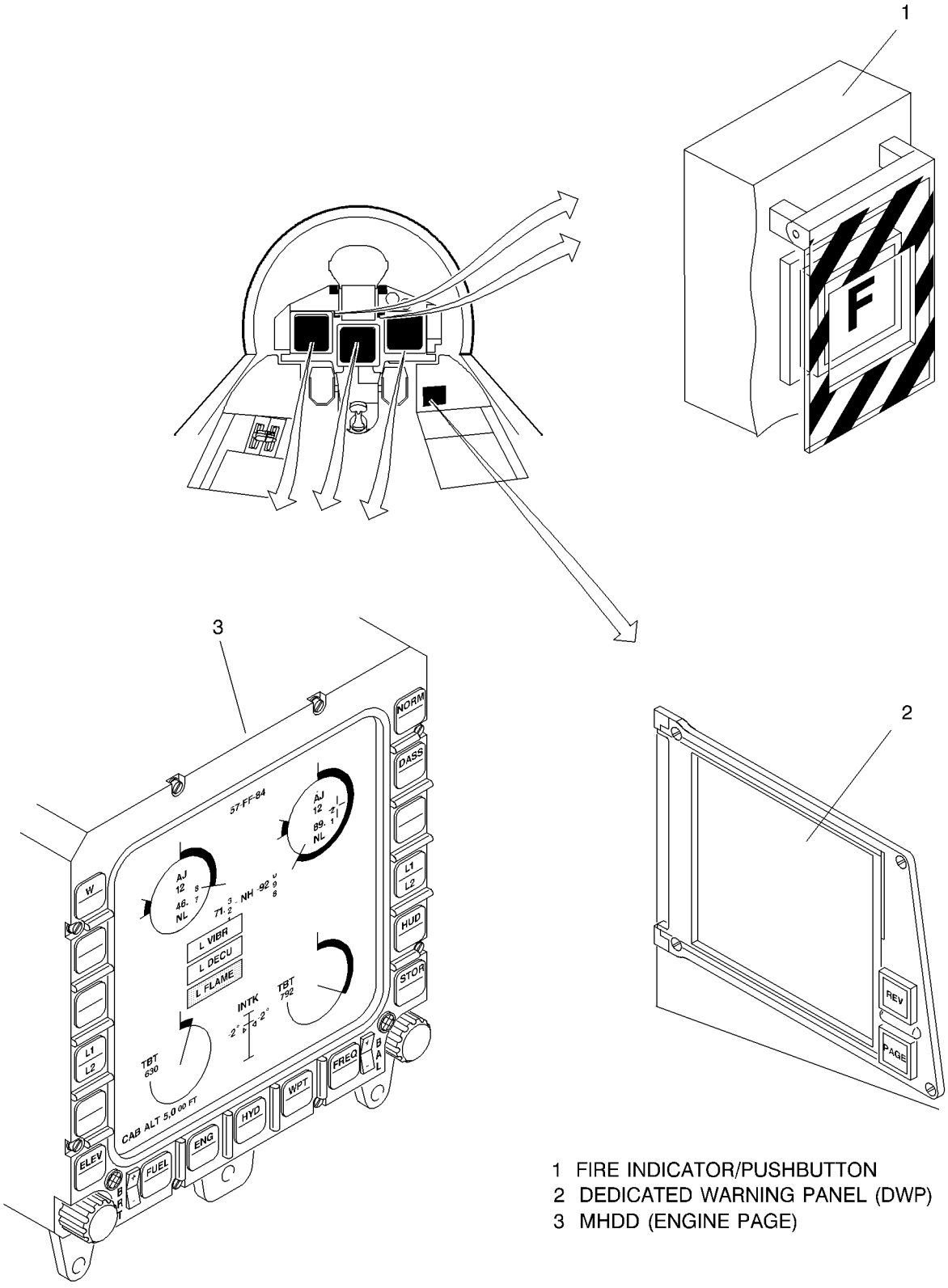
Fire Indicators / Pushbuttons

Two fire indicators / pushbuttons are located on each side of the HUD control panel. The LH indicators/ pushbuttons is for engine N.1 while the RH is for engine N.2.

The fire indicators/pushbuttons have a yellow and black hatched marked flip-up cover and are captioned "F". If a fire or overheat condition is detected in the engine bay, the relevant "F" caption illuminates steady. When the cover is raised, by pressing the pushbutton, the entire content of the fire extinguishing agent will be discharged into the selected engine bay. The "F" caption will remain displayed until the fire has been successfully extinguished.

Simultaneous operation of the left and right pushbuttons will deploy the content of the bottle into each engine bay.
The control functions are available at all times up to and including initial selection of any fire control in both cockpits. Thus further selection of the same control in either cockpit will produce no effect. However after selection of the left control (engine N.1) in the front or rear cockpit, rapid selection of the right control (engine N.2) in either cockpit will expose the right engine to the extinguishing agent source. Similarly, after selection of the right control in the front or rear cockpit, rapid selection of the left control in either cockpit will expose the left engine to the extinguishing agent source.
This mode is independent of which cockpit has flight control of the aircraft.
Should a fire occur in the rear fuselage, damage to the wiring looms can provide the following sustained or intermittent engine indications:

– TBT, NH, NL
– fuel flow (FF)
– nozzle (AJ)
– engine control warnings (L/R DECU)
– all engine related warnings.



1 FIRE INDICATOR/PUSHBUTTON
2 DEDICATED WARNING PANEL (DWP)
3 MHDD (ENGINE PAGE)

Figure 1.97 - Engine/APU Fire Protection System - Controls and Indicators

FUEL SUPPLY SYSTEM

Fuel System

(1B-B-28-00-00-00A-043A-A Issue 003)

General

Fuel is contained in two fuselage tank groups; a spine tank and four wing tanks. Fuel can also be carried externally under the fuselage and wings, in jettisonable tanks. All fuel is transferred to the fuselage tank groups before being supplied to the engines, the forward group feeding the left engine and the rear group the right engine.

Control of the fuel system is performed automatically by the Utilities Control System (UCS). Two fuel computers control the transfer and the flow rates to satisfy all the maneuver and mission requirements, and match average fuel consumption to maintain the level of the two fuselage tank groups; also referred to as main groups. If required, the automatic sequence can be overridden by use of the transfer override soft-keys on the fuel format.

The fuel gaging system utilizes signals from gage probes and level sensors in the fuel cells. These signals provide the fuel computers with information to calculate fuel content, control refuel/defuel and fuel transfer, and display fuel content information on the MHDD, reversionary GUH fuel indicators and Maintenance Data Panel (MDP).

Fuel is transferred to the two fuselage tank groups from the external tanks by air pressure, and from the wing tanks and spine tank, automatically, by transfer pumps. The transferred fuel can be manually directed to either of the two fuselage tank groups by use of the selective transfer soft-key on the fuel format.

For the cooling of hydraulic oil, gearbox oil and generator lubricating oil, some of the fuel is recirculated through Fuel Cooled Oil Coolers (FCOC). The high temperature fuel is then routed through Air Cooled Fuel Coolers (ACFC), where it is cooled by ram air before returning to the collector tanks. A restrictor, located downstream of each ACFC, prevents the fuel from boiling in the recirculation lines.

Fuel Tanks

(1B-B-28-10-00-00A-043A-A Issue 004)

Fuselage Groups

The fuselage tank system is an integral part of the fuselage structure and comprises a forward and rear group, each consisting of seven interconnected cells. The cells at the lowest point of the forward and rear group (tanks 4 and 6) are collector tanks and are supplied with fuel under gravity feed through flap valves, which prevent reverse flow. The forward collector tank houses two AC boost pumps which supply fuel to left engine. The rear collector tank houses an AC and an AC/DC boost pump which supply fuel to the right engine. In the event of a double AC failure the AC/DC boost pump will continue to function under DC power. Both groups are independent of each other, however a tank interconnect valve may be used to connect them if required.

The aircraft fuel tank locations are shown in Figure 1.98 .

Spine Tank

The space ocupied by the rear seat is occupied by the forward transfer tank on a single seat aircraft. Loss of the transfer tank is offset by the provision of the spine tank. It is located above the forward group. Fuel is transferred from the tank by two transfer pumps at the same time as fuel transfer from the aft wing tanks. When the spine tank is declared empty the remaining aft wing tank fuel is shared between the main groups. The fuel is normally transferred to the forward fuel group, although, if a failure occurs the fuel can be transferred to the rear group.

Wing Tanks

The wing tanks comprise two separate integral tanks in each wing. Fuel contained in these tanks is transferred to the fuselage groups by two transfer pumps in each tank. The fuel in the aft wing tanks is normally transferred to the fuselage rear group, although, if a failure occurs the fuel can be transferred to the front group. Upon completion of aft wing transfer, the forward wing tanks transfer jointly to both fuselage groups, due to the opening of the transfer isolate value.

External Tanks

External fuel tanks (1000 liter) can be carried at three stations; one under each wing and one under the fuselage, on the aircraft centerline. Fuel is transferred from the external tanks to the fuselage groups by pressurized air. The left external tank transfers to the forward group and the right external tank transfers to the rear group. The centerline tank, when installed, transfers to both groups simultaneously when underwing tank transfer is complete. All external tanks are jettisonable.

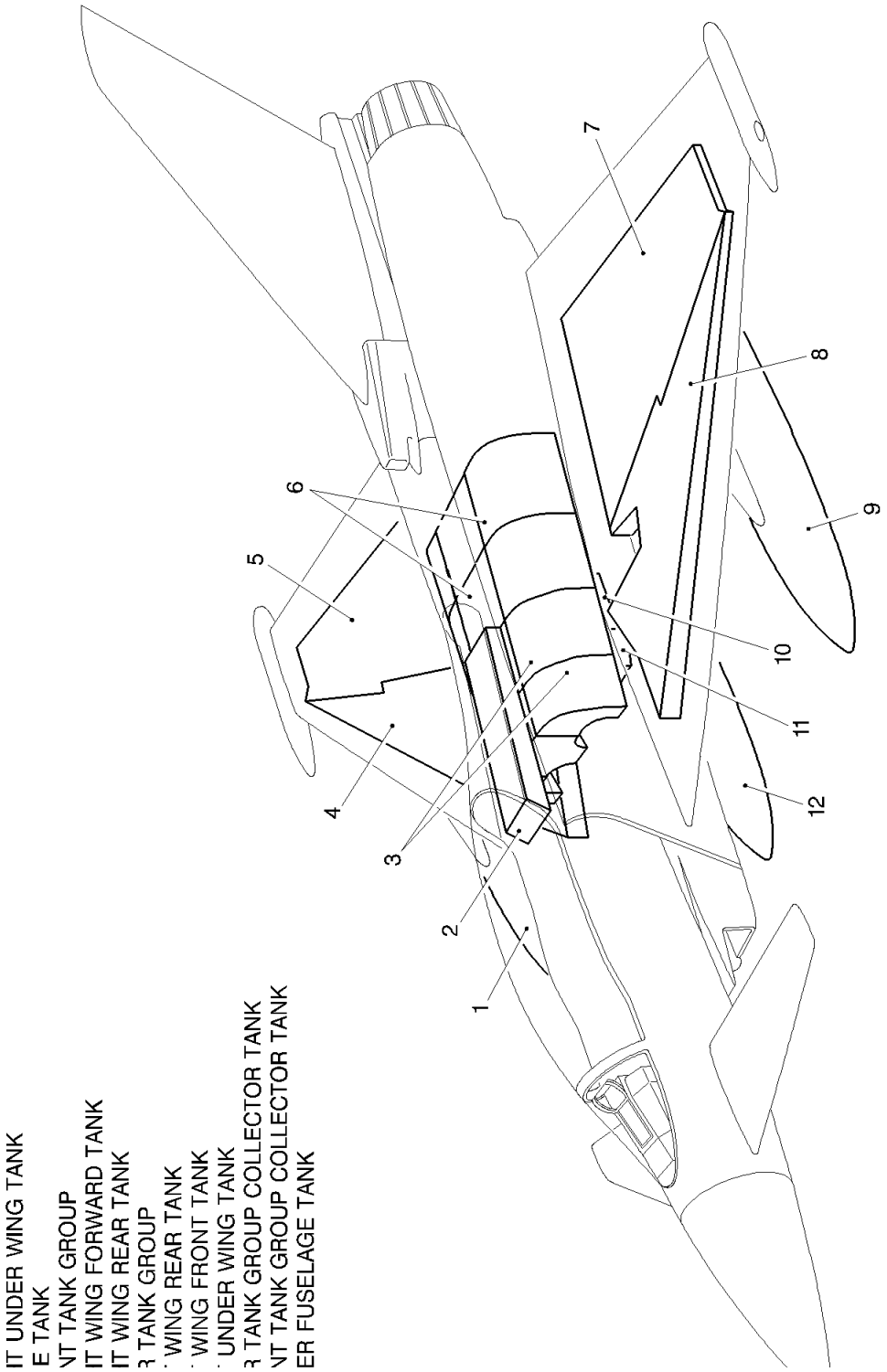


Figure 1.98 - Fuel Tank Locations

Fuel Transfer System

(1B-B-28-21-00-00A-043A-A Issue 003)

Introduction

The aircraft fuel transfer system ensures that fuel transfer is maintained to the collector tanks in all flight conditions except zero to negative g flight. During inverted flight, flapper valves ensure that fuel remains in the collector tanks, but concurrently prohibits replenishment. The transfer flow rates ensure that the main groups remain adequately supplied, but during sustained high engine demand, fuel levels in the main groups may drop, as the rate of transfer is less than the engine demand.

The fuel transfer sequence is normally controlled automatically, but manually controlled transfer is possible.

A schematic of the fuel transfer system is shown in Figure 1.99 (Note that the underfuselage external tank and associated equipment is not shown). Fuel flows into each fuselage group via the refuel/defuel/ transfer gallery and through the transfer valves, whenever the high level sensors indicate that the fuel level in either fuselage tank group has fallen by approximately 50kg from full, and at least one engine is running. This condition is maintained until the sensor indicates that the tank group is full, at which point the transfer valve will close.

Automatic Transfer

Fuel transfer is normally fully automatic and is controlled and monitored by signals from the gauging and level sensing system, and processed by fuel computers which form part of the Utilities Control System (UCS). In order to minimize CG movement during flight, transfer to the fuselage groups is sequenced as follows:

Automatic Transfer Sequence

1) Initial forward CG biasing element. 200kg is transferred from each aft wing tank to both main fuselage groups.
2) Underwing tanks (if installed), called the UW Stage.
3) Underfuselage tank (if installed), called the UF Stage.
4) Spine tank and aft wing tank and remaining fuel in the aft wing tanks, called Stage 1 Transfer.
5) Forward wing tanks, called Stage 2 Transfer.

Once the transfer tanks in each stage have been declared empty, the fuselage main groups will run down.

External Tank Transfer

An example of the fuel format during external tank transfer is shown in Figure 1.100. Fuel from the underwing tanks, if installed, is the first fuel to be transferred; both tanks into both fuselage main groups. The corresponding external tank transfer valve is opened and fuel is transferred by air pressure, controlled by the vent/pressure subsystem.

– If 3x external tanks are fitted: When the first underwing tank is detected ‘empty’, transfer will continue from the remaining underwing tank (until empty) in conjunction with the underfuelage external tank.
– If 2x external tanks are fitted: When the first underwing tank is detected ‘empty’, transfer will continue from the remaining underwing tank, unless either fuselage main group reaches a state of ‘Full - 200kg’, in which case, transfer will advance to Stage 1.
– If 1x (underfuselage) external tank is fitted: Transfer will advance to Stage 1 when the underfuselage tank is detected ‘empty’.

NOTE

During external tank fuel transfer, at low engine RPM, there is a possibility that fuel will not transfer form external tanks due to a lack of air pressure. This may be overcome by an increase in the engine RPM (>70%NL).

Stage 1 Transfer

An example of the fuel format during stage 1 transfer is shown in Figure 1.101. When all three external tanks are empty, the pressure vent valve is driven to vent and the external tank transfer valves and transfer isolate valve are closed. The appropriate transfer pumps are energized simultaneously to transfer fuel to both main fuselage groups.

The system will advance to Stage 2 when the spine tank and either one of the aft wing tanks are declared empty. However, Stage 2 transfer will also be triggered if either or both fuselage group contents are reduced to 200kg below full, following detection of the first Stage 1 tank becoming dry for >20 seconds. When Stage 2 transfer is initiated in this way, the spine tank will also be included, provided it is not already declared dry. This is called the ‘Low Flow Mode’. Once the main groups have recovered to full, and if there is still fuel available in the spine tank and either one of the aft wing tanks, the system will revert back to Stage 1 until the conditions have been met to advance to Stage 2 transfer.

Stage 2 Transfer

An example of the fuel format during stage 2 transfer is shown in Figure 1.102 . The forward wing tank transfer pumps are energized when the spine tank and either of the aft wing tanks are empty. The transfer isolate valve then opens to allow fuel to flow simultaneously into both fuselage groups. When Stage 2 transfer is initiated during the 'Low Flow Mode' the forward transfer tank will also be included, provided it is not declared dry.

Fuel Recovery Schemes

Fuel may be 'hung up' in the transfer tanks as a result of high pitch angles when the aircraft is manoeuvering at extreme attitudes. This is undesirable as it may lead to CG Warnings. Therefore a recovery scheme has been devised. (Smart First Pass, Second Pass and Main Group Rundown).

Smart First Pass

Once the aircraft recovers to normal attitude, the fuel will no longer be 'hung up' and could be transfered from respective tanks. Therefore, when the the system enters a new stage, it checks if there is fuel present in tanks depleted during the previous stages and recovers fuel from these before continuing with the stage. This is called `Smart First Pass' and ensures maximum fuel usage as well as minimising the potential for CG Warnings.

Second Pass

In addition to 'Smart First Pass', once the transfer tanks in each stage have been declared dry, the system runs through the complete transfer sequence again to recover any further fuel from the transfer tanks.

Main Group Rundown

Once all transfer is complete, i.e. all transfer tanks are empty and all the recovery schemes are complete, the main groups will run down.

Manual Transfer

Manual override of the automatic transfer system is possible in the event of damage or a failure, by soft-key selection on the fuel format. These soft-key selections from the MHDD provide the following facilities:

– The selective transfer selection (XFER FWD, XFER REAR) causes the transfer valve, unrelated to the selected group, to shut and the transfer isolate valve to open, resulting in all the fuel which is being transferred passing to the selected group.
– The transfer override selection (XFER AUTO/ UFUS/UWG/STG1/STG2) allows manual selection of the desired transfer stage.
– The tank interconnect (TANK INTC) selection connects the front and rear fuselage groups, via a motorized ball valve, to allow equalization of the fuselage groups contents should any asymmetry exist.

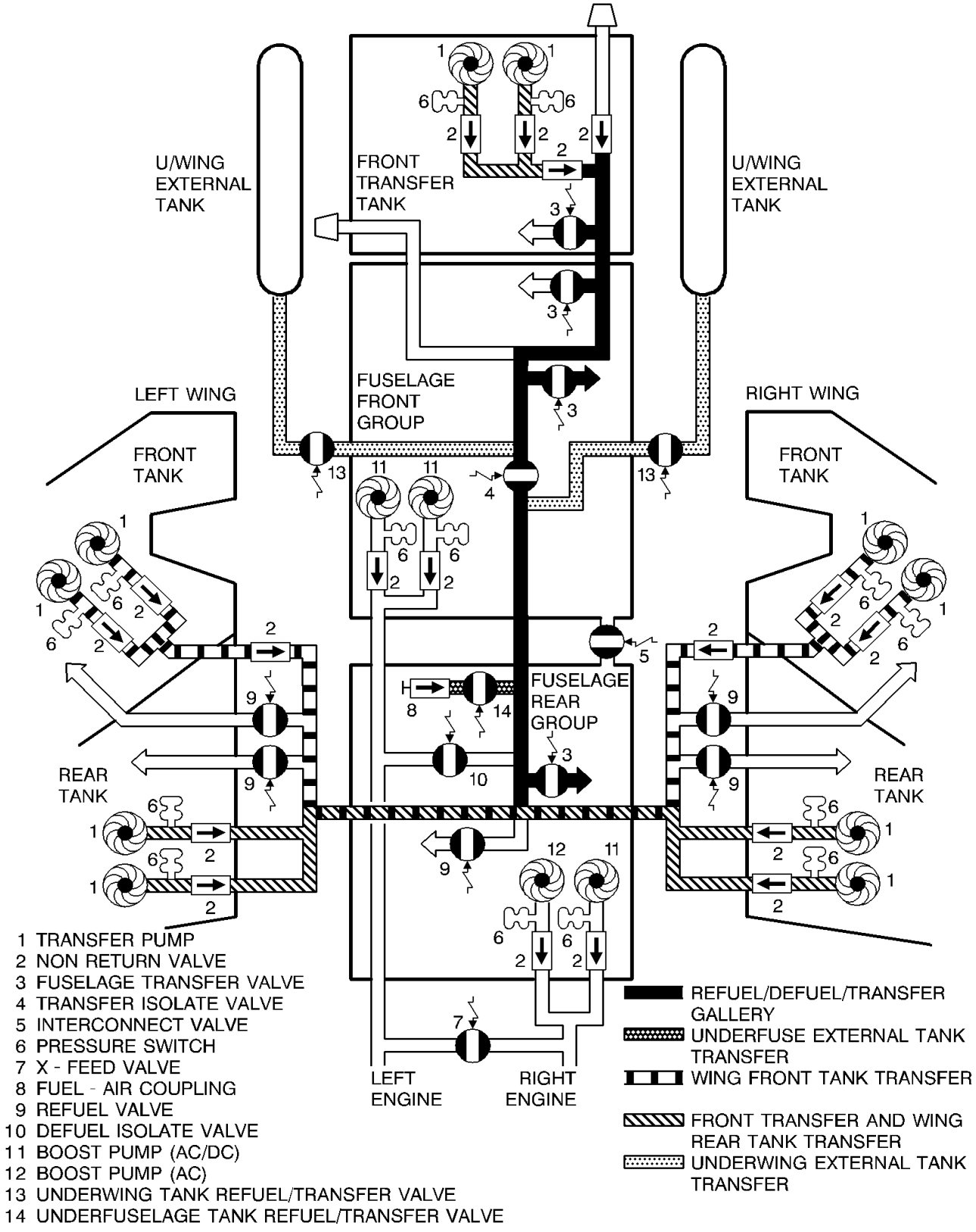


Figure 1.99 - Fuel Transfer System

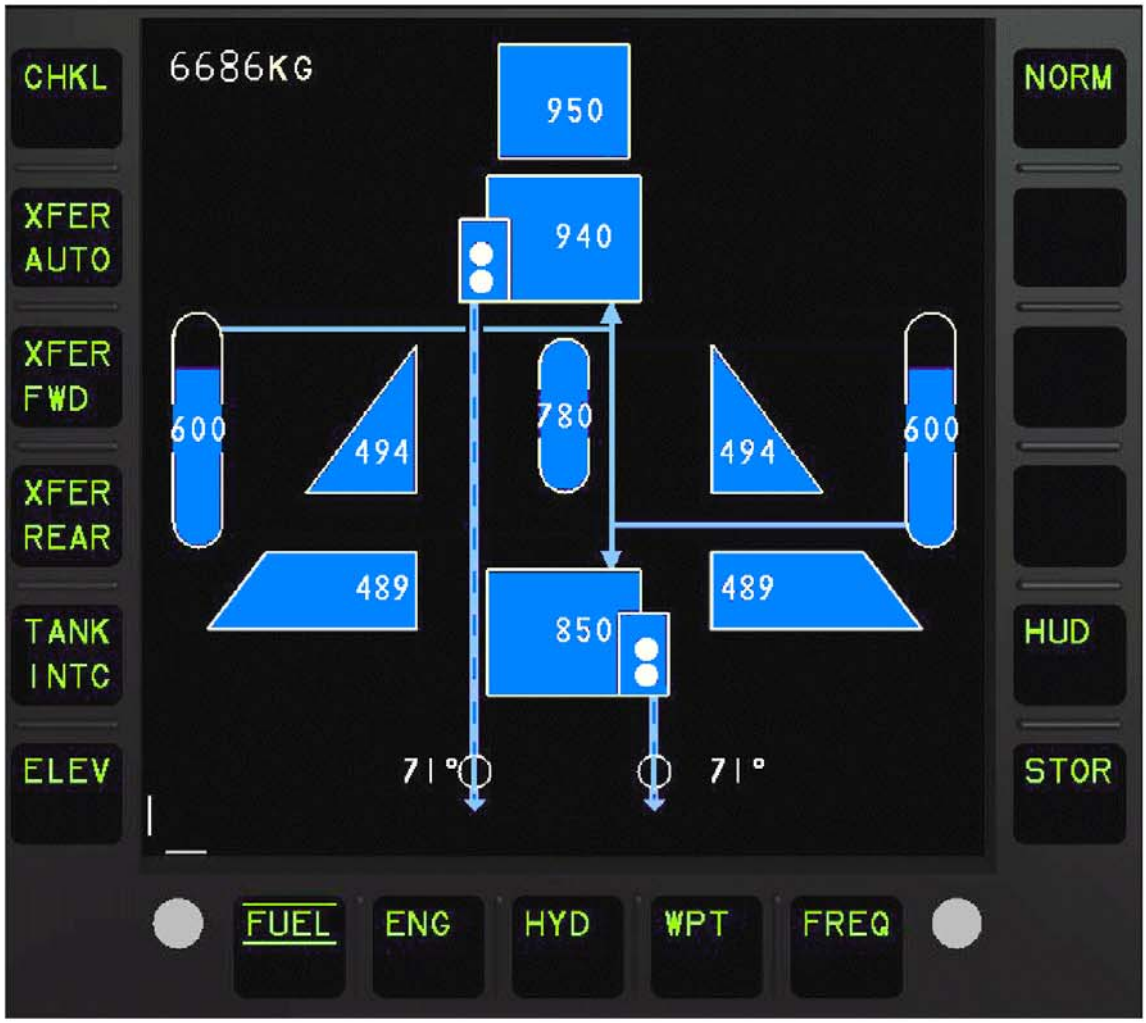


Figure 1.100 - Fuel Format (External Transfer)

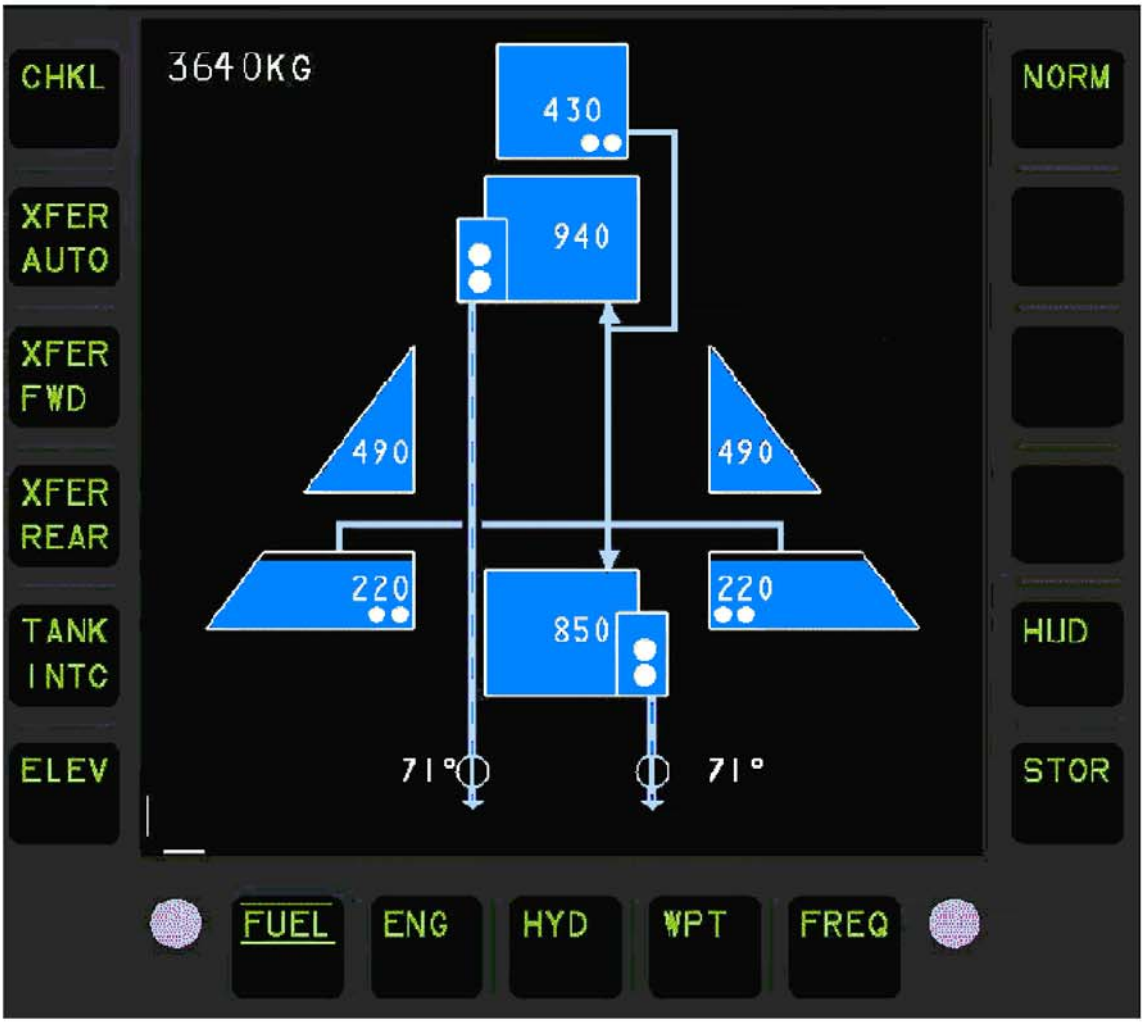


Figure 1.101 - Fuel Format (Stage 1 Transfer)

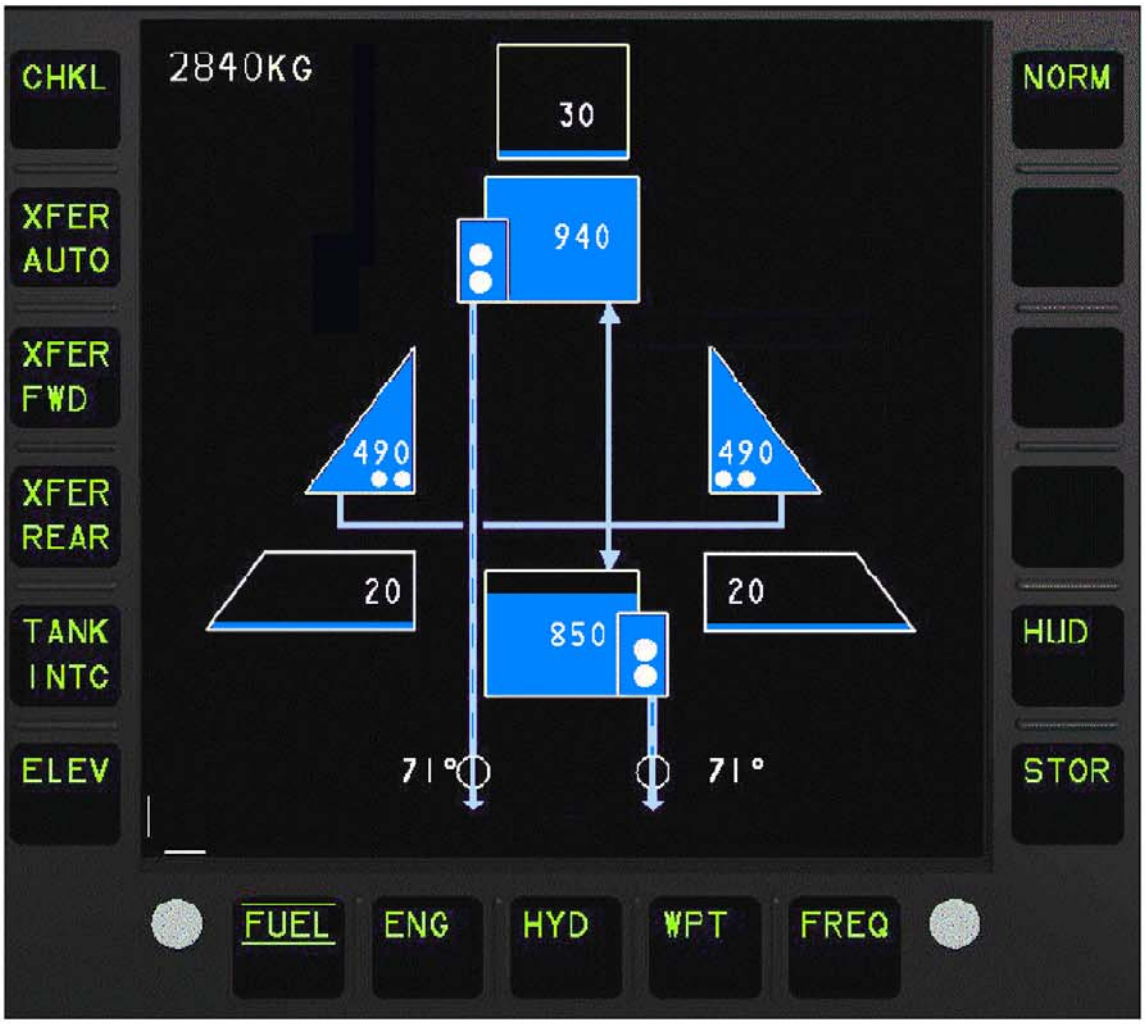


Figure 1.102 - Fuel Format (Stage 2 Transfer)

Fuel Pressurization and Vent System

(1B-B-28-14-00-00A-043A-A Issue 004)

Introduction

All the fuel tanks are pressurized to prevent fuel boiling at high temperature and altitude, and are vented to atmosphere during pressure refueling and defueling. Further tank pressurization is used to enable external tank transfer.

The pressurization also assist in maintaining engine fuel delivery in the event of boost pump failures.

Fuel Tank Pressurization

The fuel tanks are pressurized with air sourced from the ram air intake, located in the lower part of the fin leading edge. When the system is pressurized all tanks are maintained at the same pressure.

During low speed and/or high AOA, where ram air pressure alone is insufficient to maintain fuel tank pressurization, the ram air supply is automatically supplemented by low pressure bleed air. Under conditions where pressurization by ram air is negligible low pressure bleed air only is used.

Fuel Tank Venting

The tank venting system utilizes the pressurization system pipelines (Figure 1.103) and a vent package which is located in the base of the fin. The vent package consists the following:

– Ram air inlet with nonreturn valve
– Outward vent valves (2 off)
– Vent bypass valve
– Vent outlet.

Air no Fuel Valves (ANFV) are installed at the inlet/ outlets in the internal tanks (Figure 1.103). The ANFV ensure that fuel does not flow between groups during aircraft maneuvers, and that fuel spillage is minimal. An open pipeline in each of the internal tanks allows excess pressure and fuel to bypass the ANFV. Excess pressure is vented to atmosphere through an outlet near the top of the fin trailing edge. During refuel/defuel all tanks are automatically vented to atmosphere. This ensures that tank overfill does not create pressures which exceed tank proof limits or that negative pressures are created as fuel is removed.

Sensors monitor the temperature and pressure in the vent system and data is processed by the Utilities Control System (UCS) to generate any necessary warnings in the cockpit.

External Fuel Tank Transfer

During external tank transfer the external fuel tanks are pressurized using high pressure engine bleed air. The high pressure supply is used to maintain the external tanks at a pressure higher than that of the internal tanks by the use of the pressure vent valve. The high and low pressurization levels are regulated by the high and low pressure regulating valves. This ensures adequate fuel transfer to the main groups. Upon completion of external tank transfer the external tank pressure is returned to that of the internal tanks.

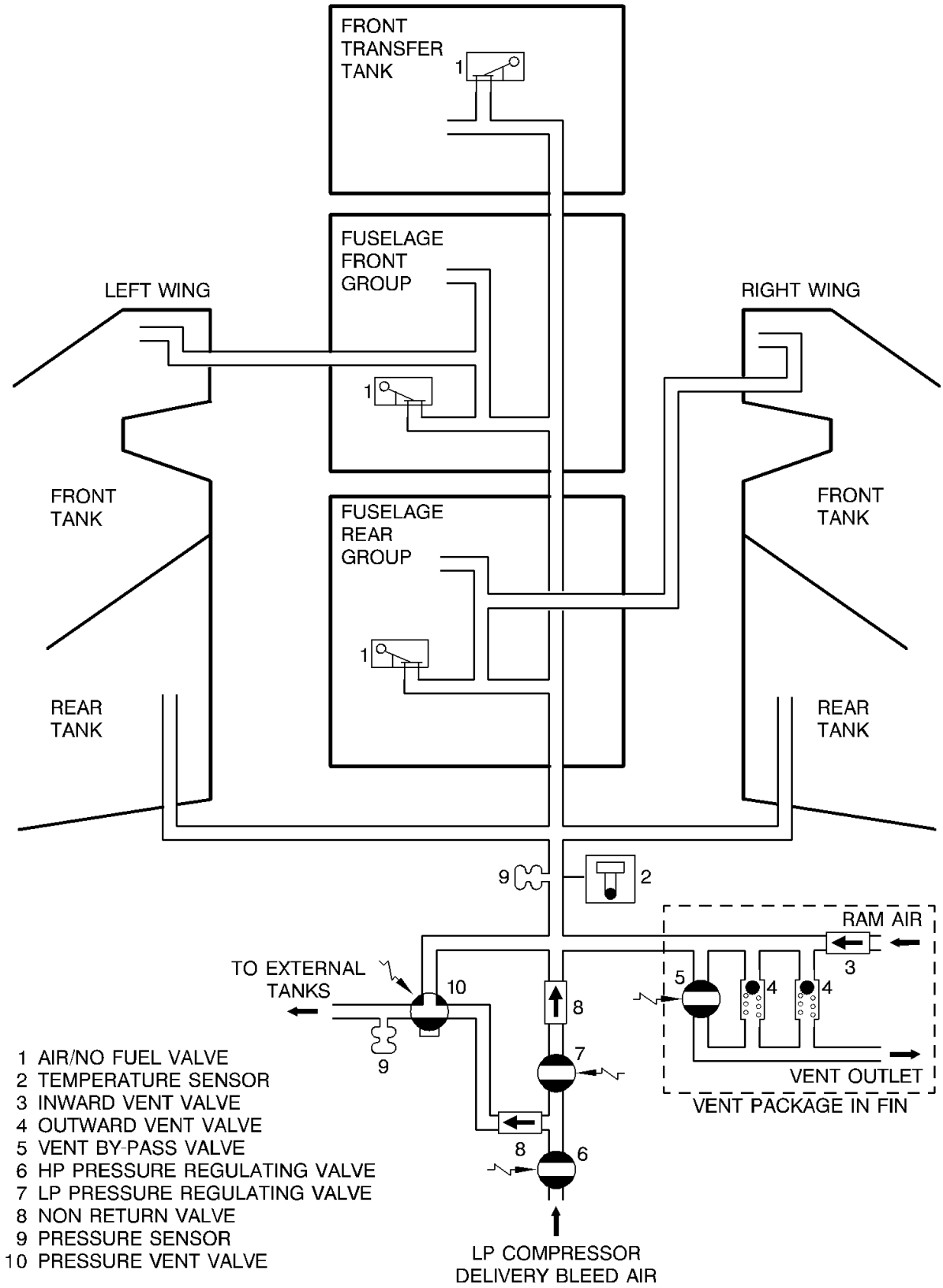


Figure 1.103 - Fuel Pressurization and Vent System

Fuel/Oil Cooling System

(1B-B-28-71-00-00A-043A-A Issue 002)

The fuel/oil cooling system (Figure 1.104) is designed to maintain the aircraft's hydraulic oil, AC generator and Secondary Power System (SPS) gearbox lubricating oils below their maximum interface temperature, in ambient conditions up to ISA +34°C. The maximum fuel interface temperature, at the engines, is 95°C.

Recirculated fuel, from a tapping on the engine feed line, passes through the Fuel Cooled Oil Cooler (FCOC). This consists of three integral heat exchangers which separately cool hydraulic, generator and gearbox oils. The FCOC incorporates a combined pressure/thermal relief bypass valve which allows the oil to bypass the cooler when the hydraulic oil temperature is below 50°C.

The heated fuel is then cooled by passing ram air through the Air Cooled Fuel Cooler (ACFC), which is mounted in a duct on the underside of the aircraft.

The cooled fuel returns to the fuselage groups, where it mixes with the contents under action of the boost pump impellers.

One boost pump in the rear fuselage tank is an AC/DC pump, and is used in the event of a double AC failure. Under these conditions this pump supplies pressurized fuel to the right engine and the right FCOC for recirculation. The left engine should be set to idle and will rely on suction feed only. The fuel contents should be monitored as a longitudinal imbalance may eventually result with differing throttle settings (tank interconnect and crossfeed valve control is denied during double AC failure).

NOTE

- During a total AC failure the left fuel supply line depressurizes, therefore fuel cooling of the left gearbox and its associated accessories is not supported with the fuel crossfeed valve remaining closed.

- A total AC generation failure combined with a total DC generation failure will result in depressurization of both fuel supply lines (the AC/DC fuel pump will not be supplied with power). Therefore fuel cooling of the gearboxes and associated accessories will not be supported.

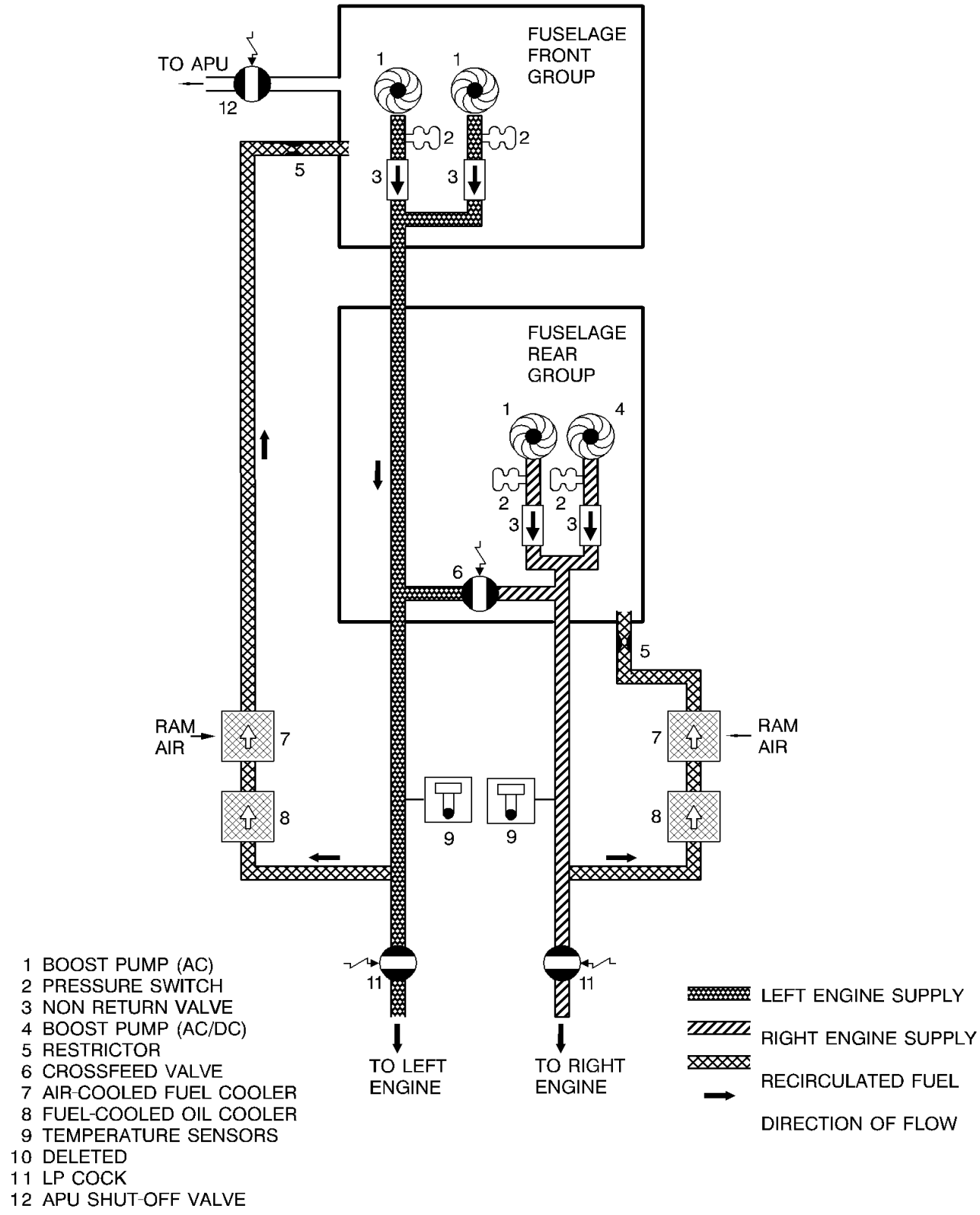


Figure 1.104 - Fuel/Oil Cooling System Schematic

Engine and APU Fuel Supply System

(1B-B-28-24-00-00A-043A-A Issue 003)

General

The engine fuel supply system Figure 1.105 provides each engine with its own independent fuel supply. The left engine is supplied with fuel from the forward fuel tank group and the right engine from the rear fuel tank group.

Fuel flows to each engine through the LP cock, which is controlled by the applicable LP COCK switch.

If required, the engine supply systems can be interconnected through a crossfeed valve, which is controlled by the XFEED NORM/OPEN switch. This enables a single engine to be supplied from both fuel groups or both engines to be supplied from one group. A XFEED caption is displayed on the MHDD/ FUEL format whenever the valve is open.

Fuel is supplied to the engines by two AC boost pumps in the collector tank of each group, which are controlled by the L and R BOOST PUMP switches. A failure of one boost pump is indicated on the MHDD/ FUEL format by the pump symbol becoming red (there are no operating limitations resulting from this failure case). If a double pump failure occurs, a red FUEL P caption is displayed on the Dedicated Warning Panel (DWP). The nonreturn valve, downstream of the pump, prevents fuel flow back through the failed pump.

One boost pump, located in the rear group, is an AC/ DC pump, used in the event of an electrical failure, which would cause the loss of AC boost pumps and possible double engine flame out. The AC/DC fuel pump is able to supply adequately pressurized fuel to support both engines in dry power, and the fuel recirculation lines automatically during a total AC failure.

NOTE

Under failure conditions where the AC/ DC boost pump is operating in the DC mode the crossfeed valve should be selected to OPEN. This will allow the pump to provide fuel feed and recirculation in both left and right systems.

NOTE

If the forward main fuselage group contains significatly more fuel than rear then the tank interconnect valve should be opened. This will balance the fuel between the main groups; providing the AC/DC pump with more usable fuel.

The APU is supplied with fuel from the forward group collector tank by gravity flow, and is controlled by the APU shutoff valve (SOV). The SOV is controlled by the APU Generator Control Unit (GCU).

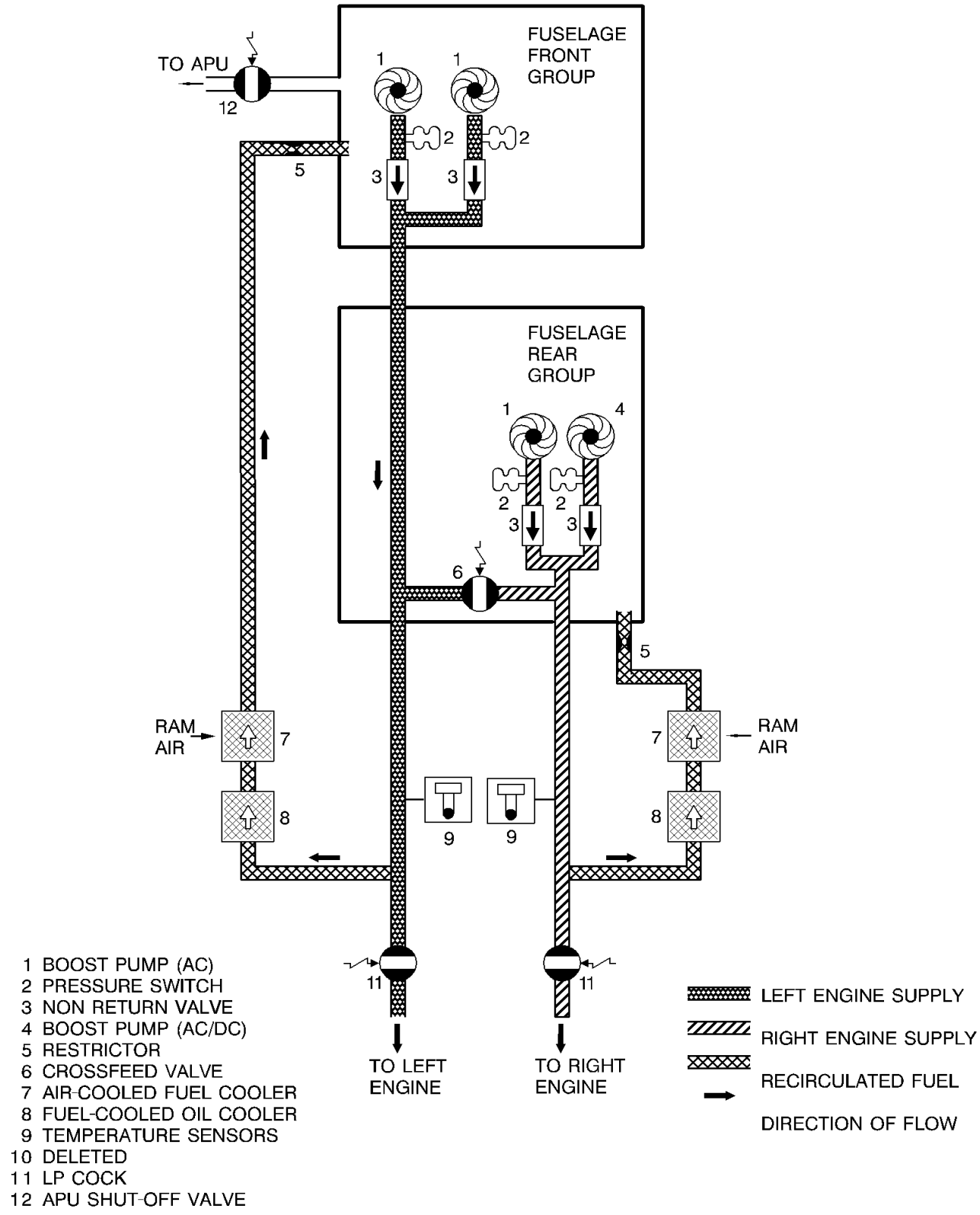


Figure 1.105 - Engine and APU Fuel Supply System

Ground Refueling and Defueling

(1B-B-28-20-00-00A-043A-A Issue 002)

Introduction

There are two methods of refueling the aircraft, and three methods of defueling:

– Pressure refueling
– Gravity refueling
– Pressure defueling
– Suction defueling
– Emergency defueling

Pressure Refueling

Pressure refueling is carried out using a single point refuel/defuel valve (Figure 1.106 and Figure 1.107) located on the left side of the center fuselage. The refueling procedure is controlled and monitored from the Maintenance Data Panel (MDP) (Figure 1.107), and all selected tanks can be refueled simultaneously to reduce ground servicing time. The refueling procedure is normally terminated automatically by the Utilities Control System (UCS), but can be interrupted or terminated at any time by pressing any key on the MDP.

Gravity Refueling

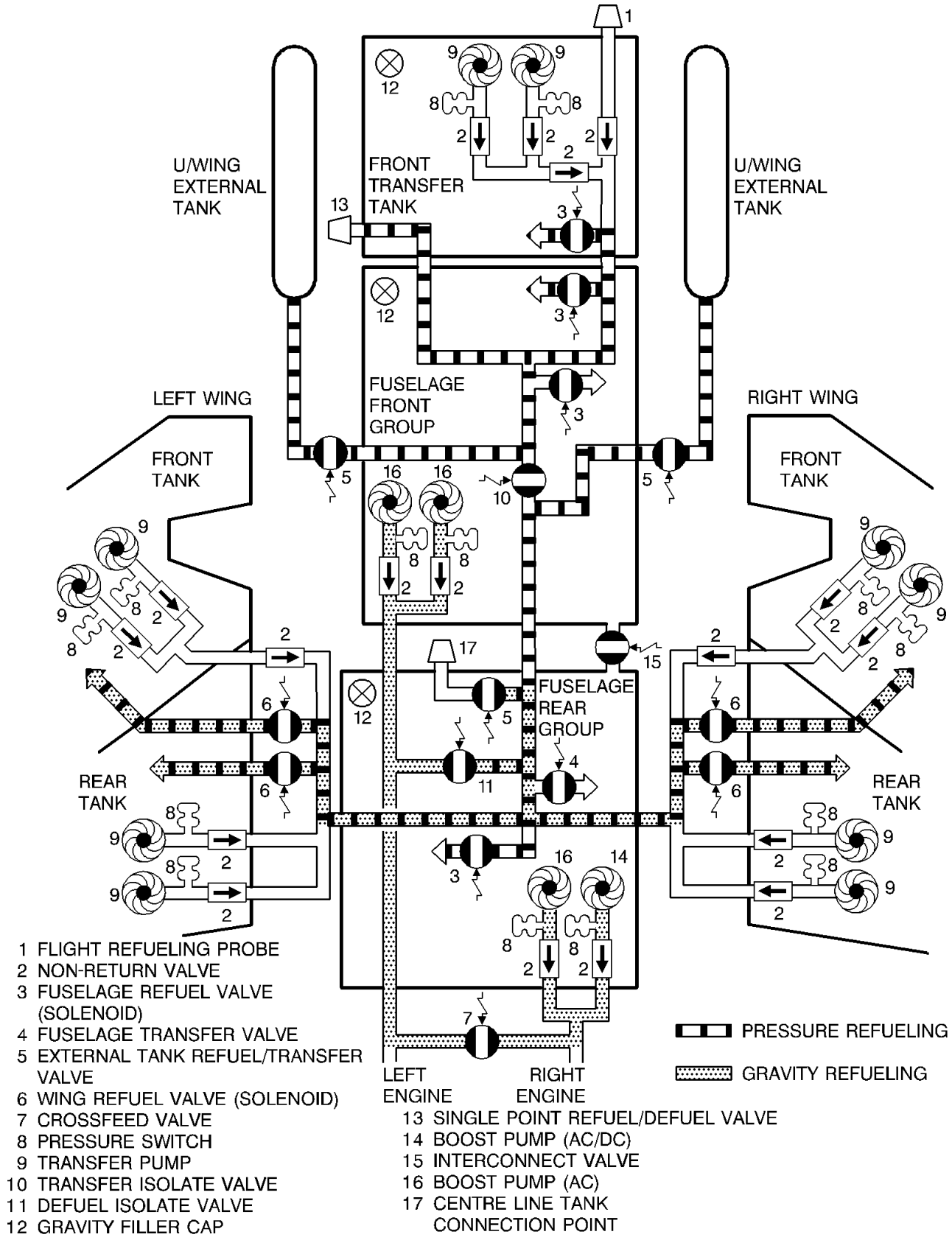
In the event that pressure refueling is not available, filler caps in each fuselage tank group, forward transfer/spine tank and each external tank (Figure 1.107) enable the aircraft to be gravity refueled. The wing tanks have no filler caps, but can be refueled via the fuselage groups.

Defueling

Pressure defueling can be carried out through the single point refueling connector and controlled from the MDP. The boost pumps are used to defuel the fuselage groups and the transfer pumps are used to defuel the forward transfer/spine and wing tanks. External air pressure supply, through a ground connector, is used to defuel the external tanks, via the refuel/defuel gallery, to the single point connector.

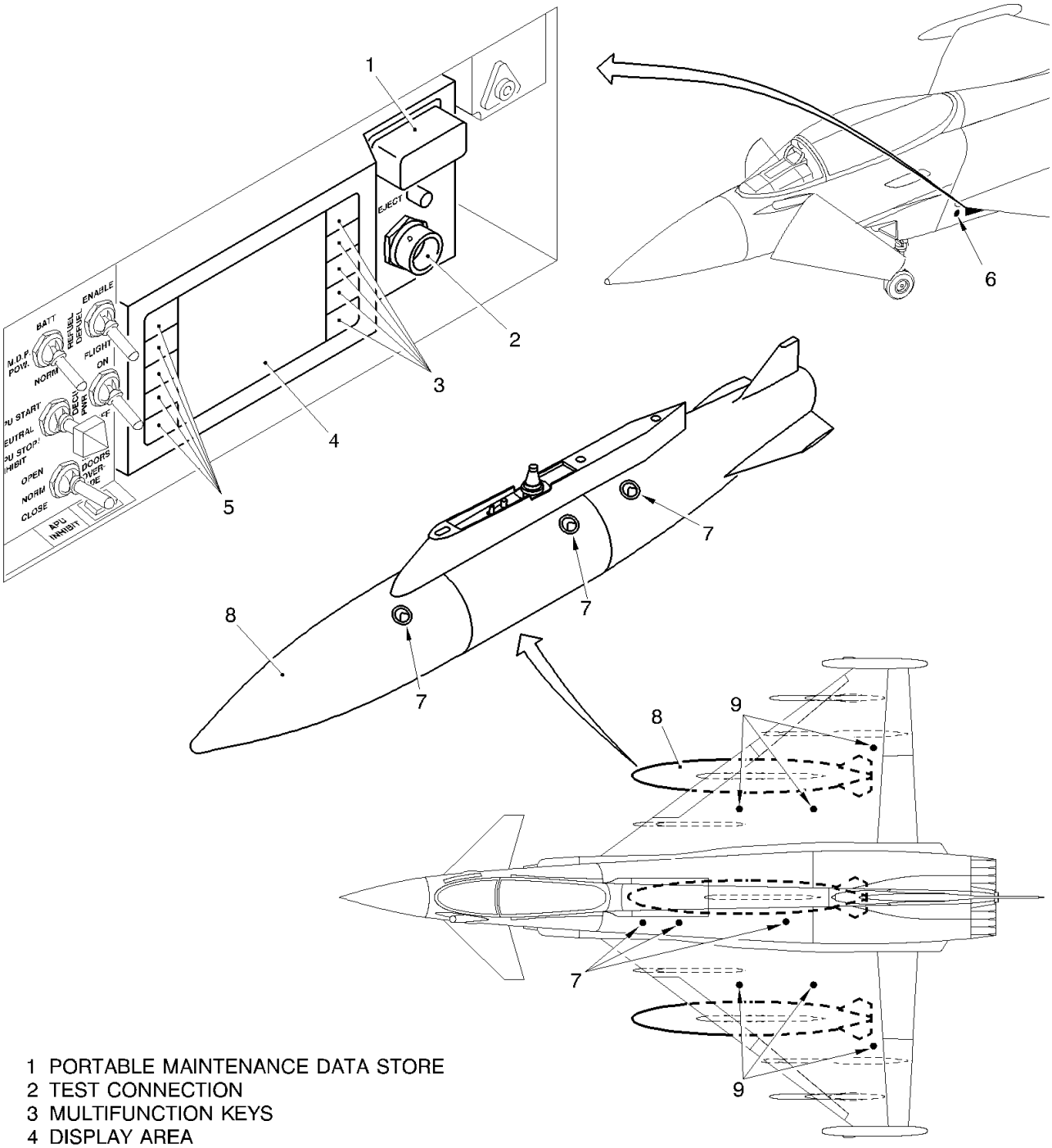
Suction defueling of all tanks, with the exception of the external tanks, is possible through the single point refueling connector. When the first tank is empty suction defueling is no longer possible as air will be entering the refuel/defuel gallery. The external tanks are defueled by suction through the tank gravity filler caps.

In the event of a wheels-up landing, partial defueling by suction is possible through the tank filler caps. The wing tanks can be `open line' defueled via the flange mounted gage probe access points.



1 FLIGHT REFUELING PROBE
2 NON-RETURN VALVE
3 FUSELAGE REFUEL VALVE (SOLENOID)
4 FUSELAGE TRANSFER VALVE
5 EXTERNAL TANK REFUEL/TRANSFER VALVE
6 WING REFUEL VALVE (SOLENOID)
7 CROSSFEED VALVE
8 PRESSURE SWITCH
9 TRANSFER PUMP
10 TRANSFER ISOLATE VALVE
11 DEFUEL ISOLATE VALVE
12 GRAVITY FILLER CAP
13 SINGLE POINT REFUEL/DEFUEL VALVE
14 BOOST PUMP (AC/DC)
15 INTERCONNECT VALVE
16 BOOST PUMP (AC)
17 CENTRE LINE TANK CONNECTION POINT

Figure 1.106 - Refuel System



1 PORTABLE MAINTENANCE DATA STORE
2 TEST CONNECTION
3 MULTIFUNCTION KEYS
4 DISPLAY AREA
5 FIXED FUNCTION KEYS
6 REFUEL/DEFUEL VALVE
7 GRAVITY FILLER CAPS
8 1000L TANK
9 FLANGE MOUNTED GAUGE PROBE ACCESS POINTS

Figure 1.107 - MDP and External Filler/Defuel Points

Air to Air Refueling

(1B-B-28-50-00-00A-043A-A Issue 003)

Introduction

The aircraft is equipped for AAR through an extendible probe located in a compartment in the right front fuselage. The probe is extended and retracted using left utility hydraulics pressure. Probe extension alone is also possible using right utility hydraulics pressure, by selecting EMGY OUT. Therefore, probe extension following left utilities failure would result in the probe being locked out.

Normal Operation

The probe is selected OUT using the AAR probe switch on the right console, and is extended hydraulically and locked hydraulically/mechanically. Selecting the probe OUT depressurizes the fuel system and inhibits the normal fuel transfer sequence, therefore fuel to the engines is taken from the fuselage fuel groups only. The normal extension sequence takes between 5 and 20 seconds, and is completed when the probe door is closed. If more than 20 seconds elapse, a Cat 3 IFR probe warning is generated to alert the aircrew to the fact that the probe is not locked.
Selecting the AAR probe OUT:

– depressurizes the vent system to allow maximum fuel flow rates and lowest tank pressures in the event of a fuel system failure during refuel
– closes the fuselage transfer valves, transfer pumps stop (normal transfer inhibited).

Emergency Operation

In the event of a left utility hydraulics failure, normal probe extension/retraction is unavailable, but the probe may still be extended using right utility hydraulics pressure, by selecting EMGY OUT. The extension sequence is the same as that for normal operation, except the front probe door remains open. The open door causes a slight increase in aerodynamic noise, but has no effect on aircraft handling or refueling drogue engagement (normal engagement techniques apply). If both hydraulics systems are working normally, there are no restrictions on the selection of EMGY OUT.
If the left utility hydraulics pressure is not available after extending the probe using the EMGY OUT selection, selecting normal IN or OUT will result in probe unlock, and partial probe retraction/collapse due to aerodynamic load: under these circumstances no attempt should be made to engage the drogue, and the ‘extending probe speed limits’ should be observed. However, selecting IN results in the fuel system returning to normal fuel transfer, which may be necessary.

MHDD/FUEL Format

After the AAR probe has successfully extended and locked, an AAR ready caption (RDY) will be displayed on the MHDD and the REFU STRT soft-key is highlighted. If the RDY caption is not displayed, AAR will not be available, however, an attempt to reset the system can be made by pressing the ‘REFU STOP/STRT’ soft-key again.
The status of the system is displayed on the MHDD and three soft-keys, marked ‘REFU STOP’, ‘REFU STRT’, and ‘REFU TOT/INT/SIM’ (depending on tank fit), enable the pilot to start, stop and restart the procedure if required, and also to refuel as desired, i.e.:

TOT	All tanks sequentially refuelled
INT	All internal tanks sequentially refuelled
SIM	All tanks simultaneously refuelled.

The desired refueling sequence may be selected at any time, before or during contact. Sequential refueling fills the tanks in the opposite order to the normal transfer sequence in order to maintain the CG position within the `carefree handling' limits. Simultaneous transfer fills all tanks at the same time, therefore CG movement may be greater. When the probe is selected out, the FCS CG warning limits are relaxed, but if a tank fails to fill, for example, the pilot will still be warned of an abnormal CG situation. If the CG warning occurs the pilot should stop refueling and diagnose the problem.
It is possible, that during simultaneous refueling, the relaxed CG limits could mask an unfavorable CG situation. If contact from the drogue is broken before all tanks are full and the probe then retracted, this unfavorable situation will become apparent due to the return of normal CG limits. In this instance the relevant CG warning drills should be performed and the necessary limits observed until the warning is cleared.
When contact is established with the drogue of the tanker aircraft, the refueling procedure is automatically started. The procedure will normally stop when all the selected tanks are full, indicated by the AAR complete caption (COMP) on the MHDD format, or if contact with the drogue is broken.

Fuel Masses

(1B-B-28-10-01-00A-043A-A Issue 003)

Useable fuel capacities are calculated at a specific gravity of 0.78.

Fuel Tank Contents

TANK GROUP	USABLE WEIGHT (KG)
Fuselage forward	995
Fuselage rear	920
Spine	350
Wing forward	504 (x2)
Wing rear	475 (x2)
Underwing (1000l x2)	1530
Underfuselage (1000l)	765
Total internal fuel	4223
Total internal + 2 external (1000l)	5753
Total internal + 3 external (1000l)	6518

Fuel System

(1B-B-28-00-00-00A-111A-A Issue 005)

Dedicated Switches and Indicators

The dedicated switches and indicators associated with the fuel system are shown in Figure 1.108.

Boost Pump Switches

Two, two-position toggle switches, labelled L and R BOOST PUMP/OFF, control the operation of the boost pumps in the fuselage fuel groups. After selection, the switches are locked in the BOOST PUMP position.

Crossfeed Switch

A two-position, lockable toggle switch labelled XFEED - NORMAL/OPEN, controls the operation of the crossfeed valve. When the switch is in the NORMAL position, the valve is closed.

LP Cock Switches

Two, two-position toggle switches labelled L and R LP COCK - OPEN/SHUT, guarded in the OPEN position, operate as follows:

OPEN	Opens the LP cock and enables the engine igniter circuit.
SHUT	Closes the LP cock and disables the engine igniter circuit.

In-flight Refueling Probe Switch

CAUTION

IF THE LEFT HYDRAULIC SYSTEM IS NOT AVAILABLE, PROBE RETRACTION MUST NOT BE ATTEMPTED.

A three-position toggle switch, guarded in the IN position, labelled FUEL PROBE - EMGY OUT/OUT/IN, controls the extension and retraction of the In-flight Refueling (IFR) probe as follows:

EMGY OUT	Probe selected to extend in emergency by the right hydraulic system. The probe can be retracted but only if the left hydraulic system is available.
OUT	Probe selected to extend by the left hydraulic system.
IN	Probe selected to retract by the left hydraulic system.

GUH Fuel Contents Indicators

Three four-digit indicators labelled FWD, REAR and TOTAL, display of the contents in kg, of the fuselage forward and rear fuel groups and the total fuel contents of the aircraft. These are shown in Figure 1.108.

Fuel Format and Soft-keys

The Fuel format and associated soft-keys are shown in Figure 1.109 .

The status of the complete fuel system is displayed on the MHDD fuel format. Once selected the format can be displayed on any of the other MHDD using the display change selector/indicators, labelled DISP CHANGE, on the pedestal panel. Soft-keys on the MHDD enable the pilot to carry out the following:

– Control the IFR system

– Override automatic fuel transfer

– Select other system formats.

Unacceptable CG Indicator

WARNING

FUEL GAUGING ERRORS WILL CAUSE ERRONEOUS AFT WING CONTENTS READINGS.

The longitudinal CG warning highlights fuel imbalance between the contents of the forward transfer tank and both aft wing tanks.

The imbalance is shown (on the fuel format) to be CG FWD or CG REAR depending on whether the content of the forward transfer tank or the aft wing tanks is the greater.

Fuel Format Controls

CAUTION

MANUAL FUEL TRANSFER OPTIONS MAY ONLY BE USED SUBJECT TO THE NECESSARY FUEL AND FCS CLEARANCES. UPON SELECTION OF ANY FUEL TRANSFER SOFT-KEY THE PILOT MUST ADHERE TO THE FCS FAILURE LIMITS.

The fuel format is selected by pressing the FUEL soft-key. When the format is displayed, the FUEL soft-key is boxed. The remaining soft-keys re-configure to present options available for selection within the fuel system. Pressing the FUEL soft-key again reverts the display to the previous format. The following options are made available via the fuel format soft-keys:

– XFER FWD is used to isolate the fuselage rear group and enable remaining transferable fuel to be transferred to the forward group. When selected, the FWD caption is highlighted. Selection causes the transfer valve related to the rear group to shut and the transfer isolate valve to open, thus enabling all fuel to transfer to the forward group tank.
– XFER REAR is used to isolate the fuselage forward group and enable remaining transferable fuel to be transferred to the rear group. When selected, the REAR caption is highlighted. Selection causes the transfer valve related to the forward group to shut and the transfer isolate valve to open, thus enabling all fuel to transfer to the rear group tank.
– XFER AUTO/UFUS/UWG/STG1/STG2 is used to override the automatic fuel transfer sequence and select the next stage before the current stage is completed. When selected, the fuel transfer selection menu AUTO/UFUS/UWG/STG1/STG2 is displayed. The soft-key is pressed repeatedly until the required stage is boxed on the menu. After a three second delay, the system will remode to the option selected and the soft-key displays the selected option. The menu will then occult. The options displayed on the menu are dependent on aircraft configuration.
– TANK INTC is used to operate the tank interconnect valve to connect/disconnect the forward and rear groups. When selected, the TANK INTC caption is highlighted and the tank interconnect line is displayed on the MHDD.
– REFU is used to enable the fuel tank configuration to be selected for IFR. When selected, the IFR configuration control menu TOT/INT/SIM is displayed. This menu is dependent upon aircraft configuration. The soft-key is pressed until the required configuration is highlighted on the menu. If the REFU soft-key is selected during a transfer/refueling operation, the operation will be suspended until the system has reconfigured.
– The use of REFU/STOP enables the IFR procedure to be interrupted if necessary. When selected, the STOP caption is highlighted.
– The use of REFU/STRT enables the IFR procedure to be restarted if previously stopped. When selected, the STRT caption is highlighted.

Fuel Format Display

The fuel format display enables the pilot to monitor the status of the complete fuel system. Information is provided on fuel tank contents, fuel transfer, fuel pumps and IFR. Fuel system warning captions are available and if displayed, are accompanied by flashing attention getters and voice warning messages.

Capacitance level and gauging probes, located inside the fuel tanks, provide analogue signals to the fuel processors of the UCS. The UCS processes the data to determine the mass of fuel in each tank, or tank group. The UCS also provides, via the MHDD fuel format, a digital readout in kg of each tank's contents, accompanied by pictorial representation (blue in-fill), which alters in proportion to the fuel contents in the respective tank. The total fuel contents are also displayed on the MHDD, and in digital form on the HUD control panel.

During normal operations, with both engines running, fuel sequencing is automatically controlled by the UCS. The boost and transfer pump symbols, relevant to the sequence, are displayed as solid

white circles. The fuel transfer lines related to each sequence are displayed in blue. Engine fuel supply lines are displayed in blue with dark blue dashes along their lengths, and the LP cocks are indicated open.
If the fuel contents in either the forward or rear group are depleted below 375kg, the figure is displayed on an amber background. If during the fuel transfer sequence a boost or transfer pump is switched off, the pump symbol is occulted. In the event of a boost or transfer pump failure, the pump symbol is displayed in red, showing a double or single pump failure. If the pressure in an engine fuel supply line is too low then the line is displayed with red dashes along its length.

NOTE

- Any usable fuel remaining in a transfer stage will be transferred to the main groups upon completion of Stage 2 transfer.

- If an external tank in the transfer sequence is detected dry for 10 seconds (20 seconds for internals) then transfer from that tank is terminated.

Two examples of fuel format displays are illustrated in Figure 1.110 and Figure 1.111 .

1 MHDD
2 GUH FUEL CONTENTS INDICATORS
3 DEDICATED WARNING PANEL
4 RIGHT LP COCK SWITCH
5 RIGHT BOOST PUMP SWITCH
6 LEFT BOOST PUMP SWITCH
7 CROSSFEED SWITCH
8 FUEL PROBE SWITCH
9 LEFT LP COCK SWITCH

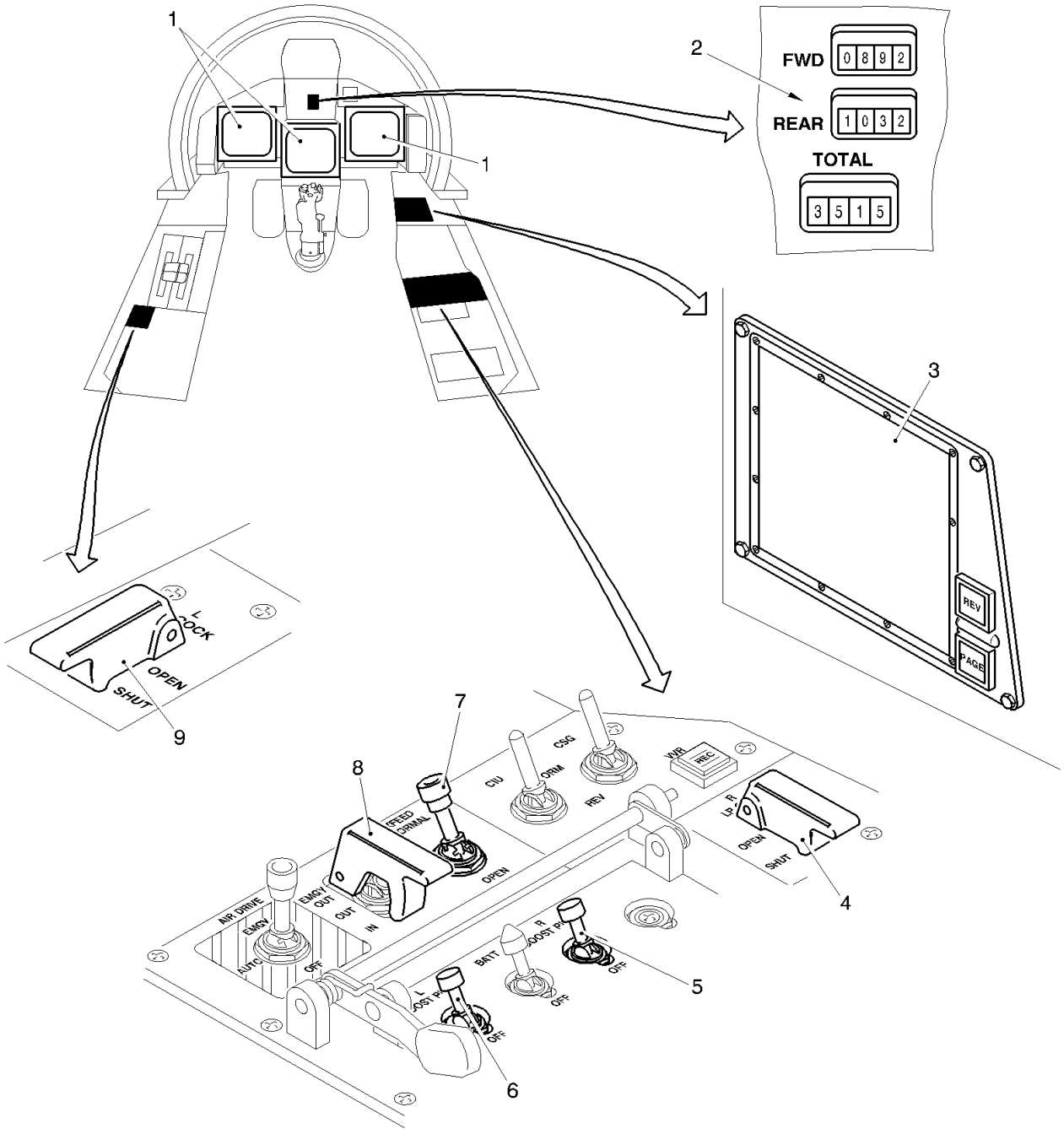


Figure 1.108 - Dedicated Fuel Supply System Controls and Indicators

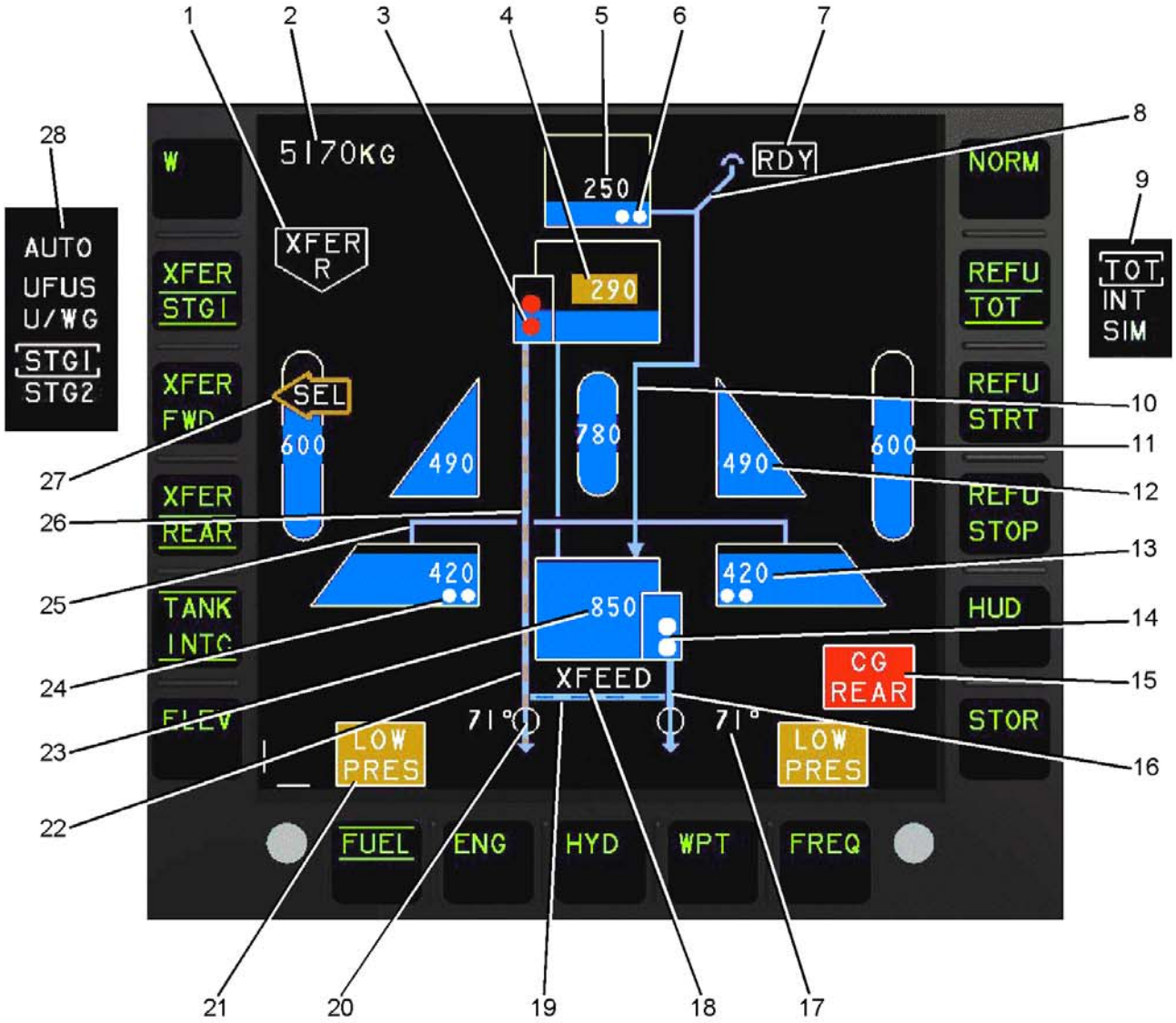


Figure 1.109 - Fuel Format and Associated Soft-keys

1	Alternative transfer indicator; R - rear, F - forward
2	Total aircraft fuel contents
3	Fuselage forward group tank boost pumps; displayed red upon failure
4	Fuselage forward group tank contents; displayed on an amber background when <375kg
5	Fuselage forward transfer tank contents
6	Fuselage forward transfer tank transfer pumps; displayed red upon failure
7	IFR probe extended; RDY - system is ready to refuel, COMP - fully refueled
8	Refuel line; displayed during IFR or transfer
9	IFR configuration control. Occulted three seconds after final selection (displayed on SK)
10	Fuel refuel/defuel/ transfer gallery
11	Right under-wing drop-tank contents
12	Right forward wing tank contents
13	Right aft wing tank contents
14	CG warning; REAR or FWD
15	Fuselage rear group tank boost pumps; displayed red upon failure
16	Engine fuel supply temperature; displayed on an amber background when >86°C, on red when >93°
17	Right engine fuel supply line; displayed with red dashes if pressure is too low
18	Cross-feed valve status; displayed when open; on a red background upon valve failure
19	Cross-feed fuel line. Displayed when cross-feed valve is open
20	LP cock status; displayed on an amber background when closed
21	Left engine fuel supply low pressure warning.
22	Left engine fuel supply line; displayed with red dashes if pressure is too low
23	Fuselage rear group tank contents; displayed on an amber background when <375kg
24	Aft wing tank fuel transfer pumps; displayed red upon failure
25	Refuel/defuel/fuel transfer lines
26	Tank interconnect line; displayed when SK5 is selected (TANK INTC)
27	Next SK selection prompt; active during alternative transfer
28	Selective transfer control. Occulted three seconds after final selection (displayed on SK)
SK2	Selective transfer soft-key
SK3	Forward transfer soft-key
SK4	Rear transfer soft-key
SK5	Tank interconnect soft-key
SK7	Fuel format soft-key
SK14	IFR stop soft-key
SK15	IFR start soft-key
SK16	IFR configuration control soft-key

Figure 1.110 - Fuel Format Example (Selective XFER - STG2 to REAR)

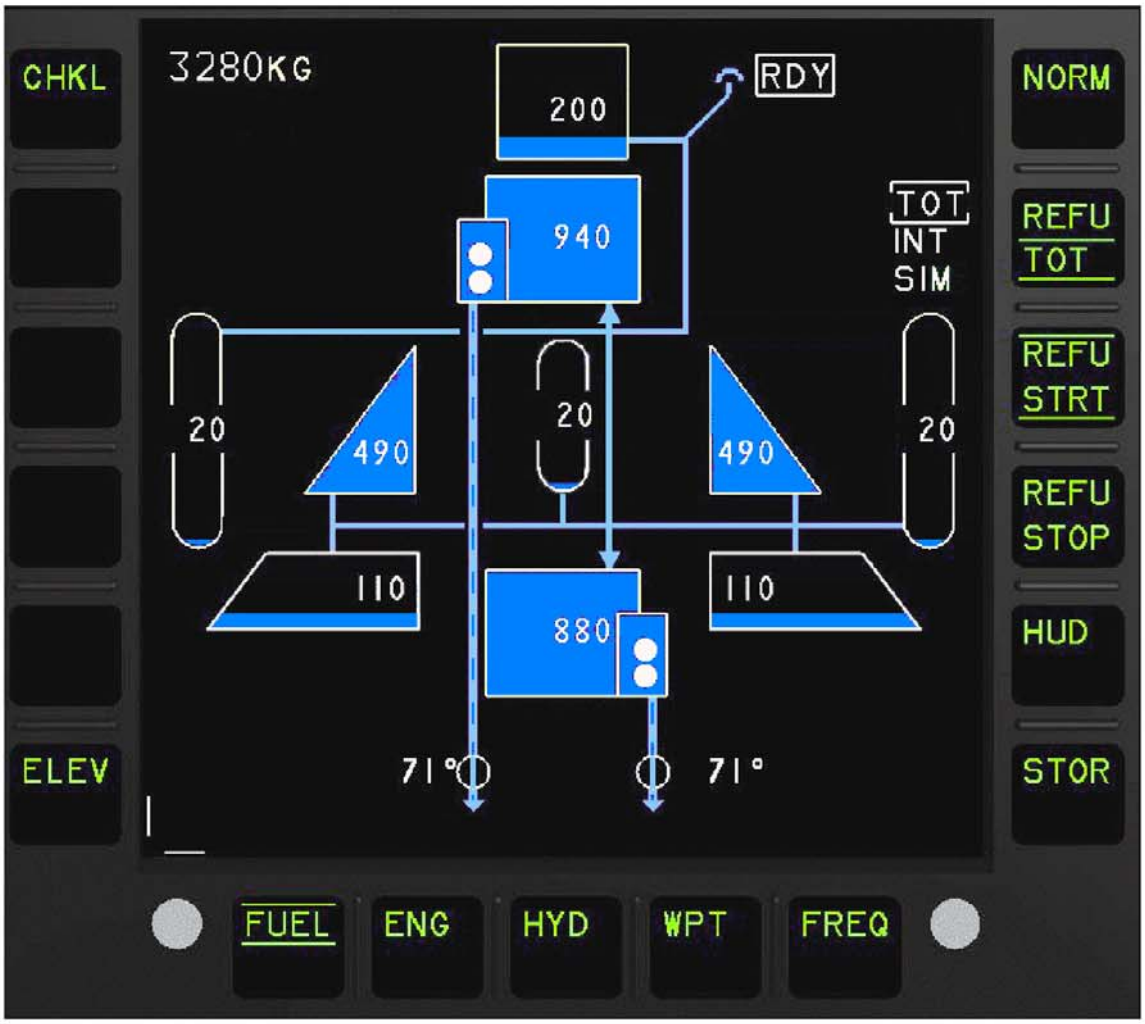


Figure 1.111 - Fuel Format Example (IFR - TOT)

ELECTRICAL POWER SUPPLY SYSTEM

Electrical Power System

(1B-B-24-00-00-00A-043A-A Issue 003)

Introduction

The Electrical Power Generation System (EPGS), Figure 1.112 , provides a 115/200Vrms, 400Hz, 3 phase, 4-wire AC supply and a 28V DC supply to meet the demand of the aircraft.
Electrical power is distributed under the control of two Constant Frequency Generator Control Units (CFGCU), via busbars and circuit breakers.

Internal Power Generation System

During normal system operation the EPGS operates as two separate channels operating independently, comprising the following:

– Two CFG providing the AC supply
– Two Transformer Rectifier Units (TRU) providing primary DC power
– Two DC generators providing reversionary DC power
– A 25Ah battery
– An APU generator providing an AC supply to both AC channels (ground only)
– A DC-DC converter.

Constant Frequency Generator

Each CFG is driven by its respective aircraft gearbox and provides a 3 phase AC power supply for one of the AC channels of the EPGS. The generated power is supplied to busbars, via a generator contactor. The busbars of the AC channels, which under normal operating conditions are electrically isolated from each other, enable the AC power to be distributed to the aircraft's electrical equipment/ systems.
Each CFG is controlled and monitored by a separate GCU. The GCU provides voltage/speed (frequency) regulation, protection functions and contactor control for the AC and DC channels. A Current Transformer Assembly (CTA) enables the GCU to provide overcurrent and differential current sensing. The CFG is equipped with an integrated drive arrangement with a constant speed drive, which ensures that the output is of constant voltage and constant frequency for varying gearbox speeds.
The CFG is able to interface with the Maintenance Data Panel (MDP) and the Dedicated Warning Panel (DWP) via the aircraft's databus system. However a dedicated hardwired warning system is provided, which enables certain GUH AC power generation warnings to be displayed on the DWP (reversionary mode only).

Transformer Rectifier Units

Each TRU is connected directly to an AC busbar and provides a 28V DC output to supply its associated essential and nonessential busbars. TRU failures are indicated on the DWP by an ELEC 1 caption (single TRU loss) or ELEC 2 (double TRU loss).

DC Generator

Two gearbox driven DC generators, controlled and monitored by their own GCU, maintain the power supply to the DC essential busbars (PP3 and PP4) during TRU fault conditions. DC generator failures are indicated on the DWP by an ELEC 1 caption.

NOTE

Left gearbox driven DC generator is connected to the right DC channel. Similarly the right gearbox driven DC generator is connected to the left DC channel.

Battery

A battery provides emergency power for use in the air (e.g. engine relight) and power for limited ground use and APU starting.
The aircraft battery is connected directly to:

– PP3 via the Battery Contactor (BC), which is controlled by the battery master switch/PP3 supply
– Maintenance busbar (PP5) via the ground service relay, which is controlled by the MDP switch
– Battery busbar (PP6)
– Supported busbar (PP7) via the DC-DC converter, under the control of the battery master switch.

APU Generator

The APU generator provides 3 phase AC power under the control of its own GCU. It is connected to AC busbar XP1 via the generator contactor GC3, and to AC busbar XP2 via the bus tie contactor BTC1, and is only operational on the ground for autonomous ground checks and ground alert mode (refer to Alert Mode/Scramble pag. 2-1).
The power rating of the APU generator alone is insufficient to support the aircraft's full electrical load for any length of time. Therefore an automatic load shedding system, controlled by both CFG GCU, is used to limit the demand on the APU generator, i.e. equipment not required during alert mode is

powered-down. During load shedding AC power is removed from certain equipment by de-energizing XP3, and by removing DC signals which enable AC power application to other equipment.
The APU GCU provides voltage regulation and the following APU generator protection functions:

– Over voltage
– Under voltage
– Over frequency
– Under frequency
– Over current
– Differential protection.

DC-DC Converter

The DC-DC converter is used to maintain a constant electrical power supply to some aircraft systems during battery supported APU starting, when the battery voltage is temporarily depressed. At all other times the DC-DC converter connects PP6 to the PP7, and also provides a permanent connection between PP3 and PP7.

External Power Supply

An external 3 phase AC power supply can be connected to the aircraft for use during ground servicing and preparation for flight. Power from this source is connected to XP2 via the Ground Power Connector (GPC), under control of the APU GCU, and to XP1 via the bus tie contactor BTC1, controlled via both CFGCU. The system has an optional capability of paralleling from ground power to the APU generator if required, however, unless configured to do so, ground power has precedence over the APU generator.

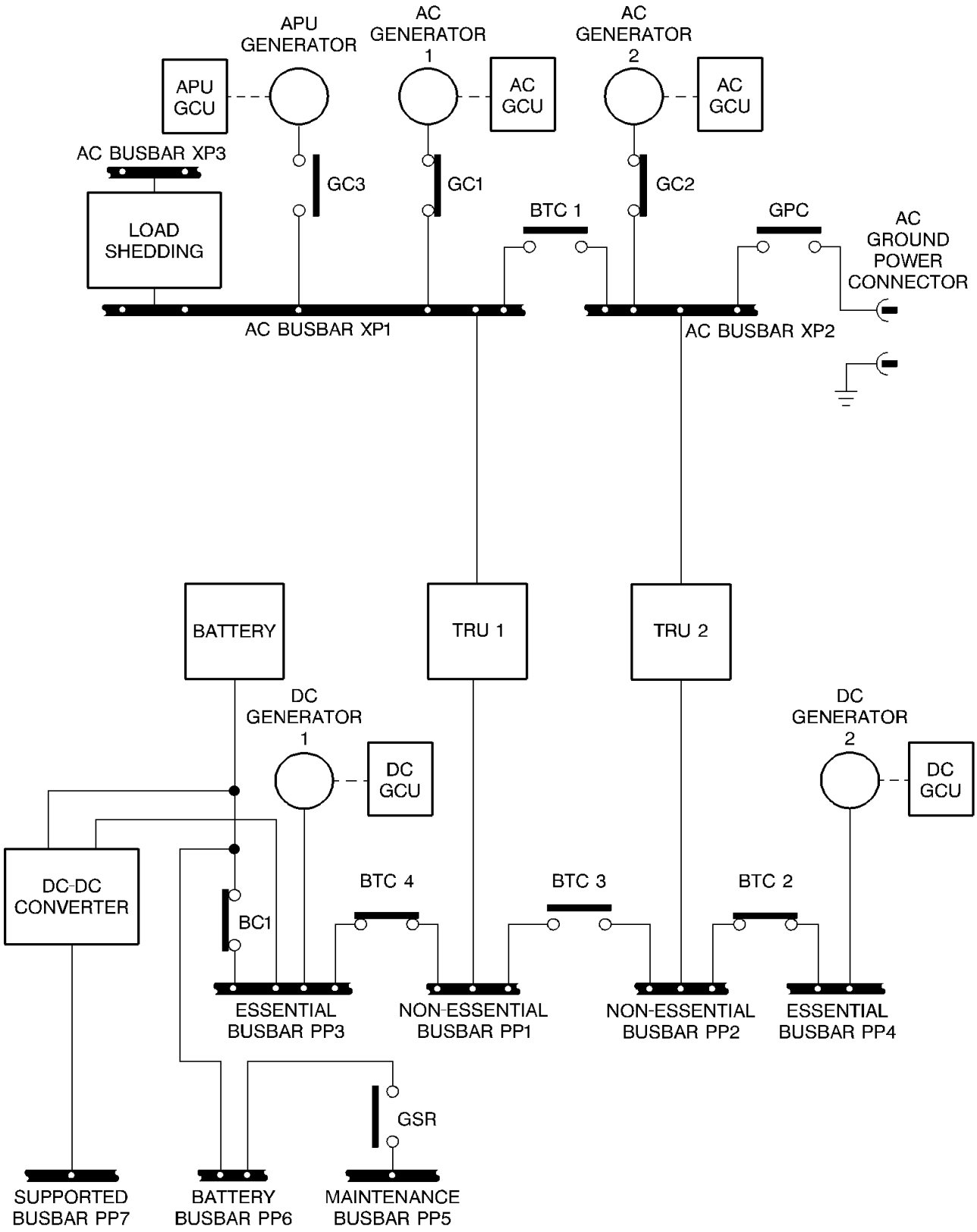


Figure 1.112 - Electrical Power Supply Schematic

AC Power Supply and Distribution

(1B-B-24-20-00-00A-043A-A Issue 004)

Introduction

Primary AC power for the aircraft is supplied by two Constant Frequency Generator, Integrated Drive Generators (CFG, IDG) channels to the AC busbars. Each IDG is capable of providing the total AC and DC power requirements for the aircraft in the event of a single CFG IDG channel failure.
AC power can also be supplied to the aircraft by either the onboard Auxiliary Power Unit (APU) AC Generator, or an external AC power source via a ground power recepticle. The APU AC generator is for ground use only and is only capable of supplying limited power to the AC electrical system.
Electrical system defects are displayed on the Dedicated Warning Panel (DWP) and the electrical system status is available for display on the Multifunction Head Down Displays (MHDD).

AC Power Supplies

Integrated Drive Generator and Generator Control Unit

The primary AC electrical power is supplied by two 30/45kVA Integrated Drive Generators (IDG). Each IDG is installed on its related accessory drive gearbox and is power rated at:

– 30kVA for continuous use
– 45kVA for two hours
– 55kVA for 5 minutes
– 60kVA for 5 seconds.

Both IDG operate independently from each other, but each is capable of supplying the total aircraft electrical load. In the event of loss of one engine. Both IDG can also be maintained ‘on line‘ using an airdrive system (crossbleed). This uses bleed air from the live engine to drive the dead engine’s accessory drive gearbox, via an Air Turbine Starter Motor (ATSM). While the aircraft is on the ground, APU bleed air can be used to drive either but not both accessory drive gearboxes.
The IDG are cooled through their related accessory drive gearboxes by oil which passes through a Fuel Cooled Oil Cooler (FCOC), this in turn is cooled by the aircraft fuel system in order to maintain a constant operating temperature. If an IDG becomes defective due to an overheat condition, it can not be reset and will need to be removed from the aircraft and returned for maintenance.
The IDG, Generator Control Unit (GCU) are micro-processor based control units which monitor and control the IDG as well as the entire aircraft AC and DC electrical system. Each GCU operates independently and either will take over monitoring and control functions of the other GCU in the event of it's failure. The GCU also provide warning and status information plus AC and DC contactor control as well as load shedding when using the APU.

Auxiliary Power Unit - AC Generator

The APU generator provides limited AC power for refuel/defuel, system testing and ground maintenance tasks when a ground power source is not available. The APU generator is monitored and controlled by its own APU Generator Control Unit (APUGCU) although the APUGCU is ultimately monitored and controlled by either/both of the CFG GCU. The APU AC generator is for ground use only and cannot be used during flight.
Because the APU generator can not supply the total requirements of the aircraft electrical system, certain non-essential equipments and systems are isolated and shut down (load shed) under the control of the CFG GCU. This prevents the full electrical load of the aircraft being placed on the APU generator.

NOTE

When using the APU to operate the accessory drive gearboxes, only one gearbox will be selected for start at any one time.

The APU AC generator is rated at:

– 10kVA continuous use
– 16kVA for 2 hours
– 20kVA for 5 seconds.

External AC power to the aircraft is monitored and controlled by the APUGCU.
Additional information for the APU is given in data module Auxiliary Power Unit pag. 1-161.

External AC Power Supply

External AC power can be connected to the aircraft via the external AC power recepticle. Before power can be supplied to the aircraft busbars, certain conditions need to be met and the decision to allow external power to the aircraft is under the control of the APUGCU via a Ground Power Contactor (GPC). The APUGCU constantly monitors and controls the external AC supply to the aircraft although the CFG GCU ultimately monitor and control the APUGCU to protect the entire aircraft electrical system.

Operation

During normal operating conditions, all electrical power for the aircraft is supplied by two CFG IDG channels. Each channel operates independently and

is controlled/monitored by its related GCU. However, if a CFG IDG channel becomes defective, the serviceable channel will be automatically reconfigured, via a bus tie contactor, to supply electrical power to the three aircraft AC busbars, XP1, XP2 and XP3. If an overcurrent (short circuit condition) is detected in the defective channel, the GCU will not allow reconfiguration of the serviceable channel and will effectively isolate the defective channel.
During APU AC generator operation, certain non-essential AC and DC loads are automatically shut down and isolated for the duration of the ‘Alert Mode‘, refer to Alert Mode/Scramble pag. 2-1. The supply will reconnect automatically when an alternative AC power source becomes available, i.e. the external AC power or a CFG IDG channel becoming available.

AC Power Distribution

The busbar distribution of AC electrical power to the aircraft systems is given in:

– Table , “XP1 Busbar,” on page 1-202 for XP1 busbar
– Table , “XP2 Busbar,” on page 1-203 for XP2 busbar
– Table , “XP3 Busbar,” on page 1-203 for XP3 busbar.

XP1 Busbar

SYSTEM/SERVICE	SUPPLIES
Propulsion	Left engine afterburner light-up detector Right engine afterburner light-up detector Left engine T2 probe (heater power supply)
ECS	Liquid cooling system pump* Front avionic fan Liquid conditioning generation unit* Rear Liquid conditioning generation unit*
Power Generation	TRU No. 1 GCU No. 1 XP1 phase A sense GCU No. 2 XP1 phase A sense APU power supply monitor
Fuel	Boost pump No. 1 (left) Boost pump No. 1 (right) Left wing aft transfer pump No. 1 Right wing aft transfer pump No. 1 Left wing forward transfer pump No. 1 Right wing forward transfer pump No. 1 Front transfer tank pump No. 1
Displays and Controls	Left MHDD Center MHDD Left MHDD (rear) Center MHDD (rear) CSG 1 CIU 1 CIU 3 (twin seat aircraft only) Left glareshield Left glareshield (rear)
DASS	Left flare dispenser Left chaff dispenser Defensive aids computer
Attack and Identification	Attack computer IFF interrogator
Armament	ACS 3 phase power channel AA
Navigation	INS
Recorders	Bulk storage device
Miscellaneous	Brake cooling fans Windscreen heater control unit A/D probe heater 1 A/D probe heater 3

* To be allocated.

XP2 Busbar

SYSTEM/SERVICE	SUPPLIES
Propulsion	Right engine T2 probe (heater power supply)
ECS	Center avionic fan
Power Generation	AC ground test socket B TRU No. 2 External ground power supply monitor GCU No. 2 XP2 phase A sense GCU No. 1 XP2 phase A sense
Fuel	Left Boost pump No. 2 Right Boost pump No. 2 Left wing aft transfer pump No. 2 Right wing aft transfer pump No. 2 Left wing forward transfer pump No. 2 Right wing forward transfer pump No. 2 Forward transfer pump No. 2
Displays and Controls	Right MHDD Right MHDD (rear cockpit) CSG 2 CIU 2 CIU 4 (twin seat aircraft only) HUD and HUD repeater
DASS	Right flare dispenser Right chaff dispenser
Attack and Identification	Radar receiver LRI 5 Radar scanner LRI 1 and LRI 29 Radar transmitter auxiliary unit LRI 3 Radar processor LRI 2 FLIR*
Armament	ACS 3 phase power channel AB
Navigation	GPS - ACU GPS - RPU GPWS Navigation computer
Communications	MIDS IFU*
Lighting	Navigation lights Formation lights Lighting controller Lighting controller (rear)
Miscellaneous	HEA* Ice detector A/D probe heater 2 A/D probe heater 4

* To be allocated.

XP3 Busbar

SYSTEM/SERVICE	SUPPLIES
DASS	Missile warner* Laser warner* Left wing tip cooling unit Left wing tip ECM/ESM PSU Avionics bay ECM/ESM PSU Right wing tip cooling unit
Power Generation	APU GCU load shed status GC1 XP3 phase A sense GC1 XP3 phase A sense
Miscellaneous	Ground test socket

* To be allocated.

DC Power Supply and Distribution

(1B-B-24-30-00-00A-043A-A Issue 004)

Introduction

The 28V DC power supply is derived from AC busbars XP1 and XP2 through transformer rectifier units TRU1 and TRU2 respectively. TRU1 supplies the nonessential busbar (PP1) and the essential busbar (PP3). Similarly, TRU2 supplies the nonessential busbar (PP2) and the essential busbar (PP4). Two DC generators with separate Generator Control Units (GCU) are connected to PP3 and PP4 respectively, to maintain supply in the case of TRU failure(s).

Emergency DC power is supplied by the 25Ah battery. The battery is connected to PP3, via battery contactor BC1, and to the maintenance busbar (PP5), via a ground service relay. This enables refueling and limited ground testing. During normal operation, the battery is charged from TRU1, via PP3.

Equipment which require a direct connection to the aircraft battery, but which do not present a permanent power drain, are supplied by the battery

busbar (PP6). Equipment which require uninterrupted power during APU start are connected to the battery supported busbar (PP7), which is fed from the battery via a DC-DC converter.
DC distribution is shown in Table , “PP1 Nonessential Busbar,” on page 1-205 , Table , “PP2 Nonessential Busbar,” on page 1-206, Table , “PP3 Essential Busbar - Battery Maintained,” on page 1-207 , Table , “PP4 Essential Busbar,” on page 1-209 , Table , “PP5 Maintenance Busbar,” on page 1-210, Table , “PP6 Battery Busbar,” on page 1-210 and Table , “PP7 Battery Supported Busbar,” on page 1-210 .

Control and Protection

The DC system is monitored and partially controlled by both CFGCU and is protected by the bus tie contactors BTC2, BTC3 and BTC4 (bus tie contactors isolate parts of the DC system in the event of a busbar short circuit to earth or loss of TRU output). The user systems are protected by circuit breakers.

NOTE

Both DCGCU carry out monitoring/ control of the DC generators only.

PP1 Nonessential Busbar

SYSTEM/SERVICE	SUPPLIES
Displays	Center MHDD control Left MHDD control
ECS/MSOC	Avionic 3-way SOV Fan 3-way SOV Emergency 3-way ram air valve ECS warning horn Avionic/center fuselage fan speed transducers Liquid pump speed transducer Zirconia oxygen monitor Liquid conditioning generation unit (front) Liquid conditioning generation unit (rear)
Fuel	Forward and rear group refuel valves Left and right fore wing refuel valves Defuel isolate valve Underfuselage refuel/ transfer valve Transfer 1 pump control (various)
Power Generation	DC ground test socket A Battery heater test Battery heater GCU1 busbar monitor GCU2 busbar monitor
Recorders	Sensor and signal conditioning units (x6) VVR
Lighting	Landing/taxi light control Left taxi light supply Right landing light supply Anticollision light Left taxi light supply
Communications	CAMU
Navigation	Precision distance measuring equipment
DASS	Missile approach warner + PS decoy Left wing tip pod cooling unit Right wing tip pod cooling unit Forward detector unit Rear left detector unit Rear right detector unit
Attack and Identification	IFF interrogator

PP2 Nonessential Busbar

SYSTEM/SERVICE	SUPPLIES
Displays	Right MHDD control Right MHDD control (rear cockpit) Right glareshield Right glareshield (rear cockpit)
Fuel	Forward transfer tank/ refuel valve Left and right aft wing tank refuel valves Pressure/vent valve Forward and rear group transfer valves Left and right underwing refuel/transfer valves Stage 2 transfer pumps control Tank interconnect valve Left and right boost pump control No 2
Power Generation	DC ground test socket B GCU1 busbar monitor GCU2 busbar monitor LDR2 (MHDD and WSHCU) LDC1
Recorders	Mission data loader/ recorder Sensor and signal conditioning unit (x4)
Lighting	Anticollision light Left landing light supply Right taxi light supply
Armament	ACS VDC 2 power - channel AB ACS VDC 1 power - channel AB ACS VDC 2 power - channel AB (secondary) ACS VDC 1 power - channel AB (secondary)
Navigation	Microwave landing system R-NAV TACAN
DASS	RF decoy deployment
Communications	V/UHF transceiver 2
Radar	Radar control + WGU
Miscellaneous	Windscreen heater controller HEA

PP3 Essential Busbar - Battery Maintained

SYSTEM/SERVICE	SUPPLIES
Propulsion	Right DECU power supply line 1 Left DECU power supply line 1 Left DECU service supply line 1 Right DECU service supply line 1 Right high energy ignition unit line 1 Right high energy ignition unit line 2 Left high energy ignition unit line 1 Left high energy ignition unit line 2 Left engine probe heater Left engine low oil pressure warning Left engine fire detection warning Right engine fire detection warning EMU supply Right engine low oil pressure warning
ECS, MSOC and front computer	Engine bleed air SOV ECS SOV Bleed air variable pressure SOV Ejector SOV Precooler bypass valve Temperature control valve Demist SOV Antimist SOV Airflow control valve MSOC solenoid valves MSOC pressure regulating SOV Right engine bleed SOV Oxygen concentration monitor Bleed air leak detection system Oxygen changeover valve + override solenoid (auxiliary oxygen) NBC ventilation Front computer Aircrew services package relay
Displays	DWP DWP (rear) HUD (rear) Right glareshield Right glareshield (rear)
FCS and cowl	FCS computer 1 FCS computer 2 FCS computer 3 FCS computer 4 FCS actuator supplies 3 FCS actuator supplies 4 Inertial motion unit 1 Inertial motion unit 2 Inertial motion unit 3 Inertial motion unit 4 Right emergency cowl Left emergency cowl
Fuel	Left LP cock Right LP cock Fuel crossfeed Engine feed monitoring AAR reference Left fuel computer Left and right boost pump No 2 control Transfer isolate valve Fuel gaging interface unit Vent bypass LDC2 Battery over temperature warning Battery contactor DC-DC converter GCU1 and 2 busbar monitor
Power Generation	DC ground test socket A ACS VDC1 power channel AA ACS VDC2 power channel AA (secondary) TRU 1 fault annunciator TRU 2 fault annunciator DC GCU 4 DC GCU 4 (backup supply) DC GCU 3 (backup supply)

SYSTEM/SERVICE	SUPPLIES
Hydraulics	Utility isolation valve system 1 Hydraulic pressure switch system 1 Hydraulic pressure switch system 2 Hydraulic depressurization valve system 1 (pump) Hydraulic catastrophic failure warning
Data recording	Interface processor unit CSMU CSMU write enable MDP Mission data loader/ recorder
Landing gear brakes and hook	Landing gear computer PS1 Brake and antiskid equipment 1 Emergency landing gear selection WOW relay system 1 Arrestor hook uplock solenoid A
Lighting	Lighting controller Lighting controller (rear) Lighting mode selector
Armament	MASS indication power supply AA MASS indication power supply AB ACS VDC 1 power - channel AA ACS VDC 2 power - channel AA SCAC
Secondary power system	Left SPS system
Navigation	IN system
Attack and Identification	IFF interrogator

SYSTEM/SERVICE	SUPPLIES
Miscellaneous	Canopy relay + computer discrete inputs Cockpit throttle box Cockpit throttle box (rear) IP seat raise/lower IP seat raise/lower (rear)

PP4 Essential Busbar

SYSTEM/SERVICE	SUPPLIES
Propulsion	Left DECU power supply line 2 Right DECU power supply line 2 Right engine probe heater Left DECU service supply line 2 Right DECU service supply line 2
Displays	Left glareshield Left glareshield (rear) HUD HUD (rear) DWP DWP (rear) DWP cooling fan DWP cooling fan (rear)
FCS, cowl and auto-throttle	FCS computer 1 FCS computer 2 FCS computer 3 FCS computer 4 FCS actuator supply 1 FCS actuator supply 2 Inertial motion unit 1 Inertial motion unit 2 Inertial motion unit 3 Inertial motion unit 4 Right emergency cowl Front throttle box (autothrottle function) Rear throttle box (autothrottle function)
Fuel	Engine feed monitoring Emergency fuel Emergency fuel pump indicator Transfer isolation valve Fuel gaging interface unit Right fuel computer Emergency AAR probe selection
Power Generation	DC ground test socket B DC GCU 3 GCU 1 busbar monitor GCU 2 busbar monitor
Hydraulics	Utility isolation valve system 2 Depressurization valve system 2 (pump)
Landing gear, brakes, chute and hook	Landing gear computer PS 2 Chute door lock release Arrestor hook uplock B Arrestor hook indication Brake and antiskid system 2 WOW relay system 2 Landing gear main doors override
Lighting	Lighting controller (rear)
SPS	Right SPS system Right SPS computer
Navigation	Radar altimeter
FLIR	ON/OFF switch
DASS	Right wing tip towed decoy PSU
Miscellaneous	ACVMU UTC clock UCS front computer

PP5 Maintenance Busbar

SYSTEM/SERVICE	SUPPLIES
Fuel	Ground refuel function (x4) Left fuel computer Right fuel computer
Landing gear	Landing gear computer PS 1 Landing gear computer PS 2
SPS	Left SPS computer Right SPS computer
Miscellaneous	MDP FLIR UCS front computer

PP6 Battery Busbar

SYSTEM/SERVICE	SUPPLIES
Power Generation	Battery contactor Battery monitor Ground service relay supply PP5 busbar supply DC-DC converter DC-DC converter battery master switch DC-DC converter auxiliary output no 1 DC-DC converter auxiliary output no 2 DC-DC converter auxiliary output no 3
SPS	APU control unit
Miscellaneous	Park brake module Canopy control and warning horn Engine fire extinguishers APU fire detection Canopy power Cockpit ladder

PP7 Battery Supported Busbar

SYSTEM/SERVICE	SUPPLIES
Power Generation	Ground test socket CFG GCU1 DC supply + GC1 + BTC1, 2, 3, 4 drives CFG GCU2 DC supply + GC2 + BTC1, 2, 3, 4 drives TRU1 off line signal driver TRU2 off line signal driver DC-DC converter DC-DC converter HMS power supply DCGCU3 DCGCU4
Communications	CAMU V/UHF transceiver no 1 HEUB
SPS	APU GCU + GPC + GC3 drives
Miscellaneous	Head up panel Crypto-erase relay

Electrical Power System

(1B-B-24-00-00-00A-111A-A Issue 003)

Introduction

The controls and indicators associated with the electrical system (Figure 1.113) are as follows:

– Battery master switch
– Dedicated Warning Panel (DWP)
– Attention getters
– APU START/STOP switch
– APU status indicator

The controls and indicators associated with the electrical system (Figure 1.113 and Figure 1.114) are as follows:

– Battery master switch (front cockpit only)
– Dedicated Warning Panel (DWP)
– Attention getters
– APU START/STOP switch (front cockpit only)
– APU status indicator

Battery Master Switch

The battery master switch is a two position toggle switch, labelled BATT/OFF, lockable to the BATT position. It enables all systems connected to the

battery supported busbar (PP7) to receive a nominal 22.8V DC, via the DC-DC converter, prior to Electrical Power Generation System (EPGS) start-up. The battery also supplies the essential busbar (PP3), maintenance busbar (PP5) (when ground service relay is energized) and battery busbar (PP6) (connected to the battery at all times).

Failure Indicators

A dedicated hardwired warning system provides failure indications to the DWP. The hardwired warning system provides warning of the following failure conditions:

– Total AC generation failure (left and right AC generators); the caption is 'AC'
– Essential DC failure (loss of multiple LRI, resulting in immediate/subsequent loss of an essential DC busbar); the caption is 'ESS DC'.

Other warnings are sent to the DWP via databus; level warnings and discrete warnings.

– Level warnings:
  - 'ELEC1': Loss of any single LRI, but all busbars available
  - 'ELEC2': Loss of multiple LRI resulting in immediate/subsequent loss of a system busbar

– Discrete warnings:
  - Left/right AC generator fail: Loss of one AC generator or its associated GCU; caption is 'L GEN' / 'R GEN'
  - Left/right AC generator overtemperature: Temperature of AC generator in excess of 165°C; caption is 'L GEN T' / 'R GEN T'
  - Battery overtemperature: Battery temperature in excess of 72°C; caption is 'BATT T'.

The failure indications are accompanied by flashing attention getters, positioned on the left and right glareshields.

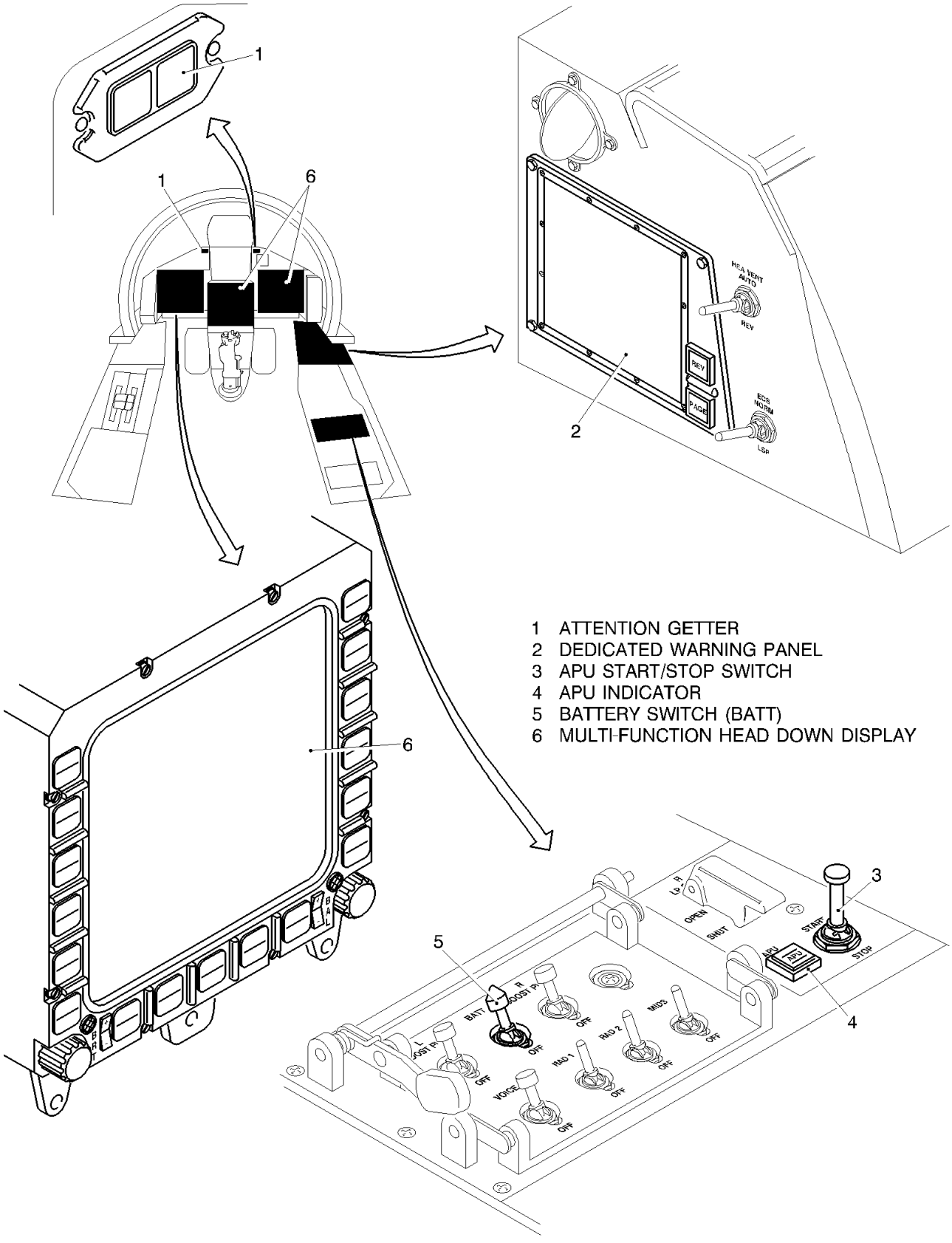
Audio Warnings

Each warning caption associated with the electrical power system is accompanied by an audio (attenson plus voice) warning, generated by the Communications and Audio Management Unit (CAMU) and transmitted to the headsets. The voice warnings are as follows:

AC	"Double AC"
ESS DC	"Essential DC"
ELEC2	"Electrical second fail"
ELEC1	"Electrical first fail"
L GEN T	"Left generator overheat"
R GEN T	"Right generator overheat"
L GEN	"Left generator"
R GEN	"Right generator"
BATT T	"Battery overheat"

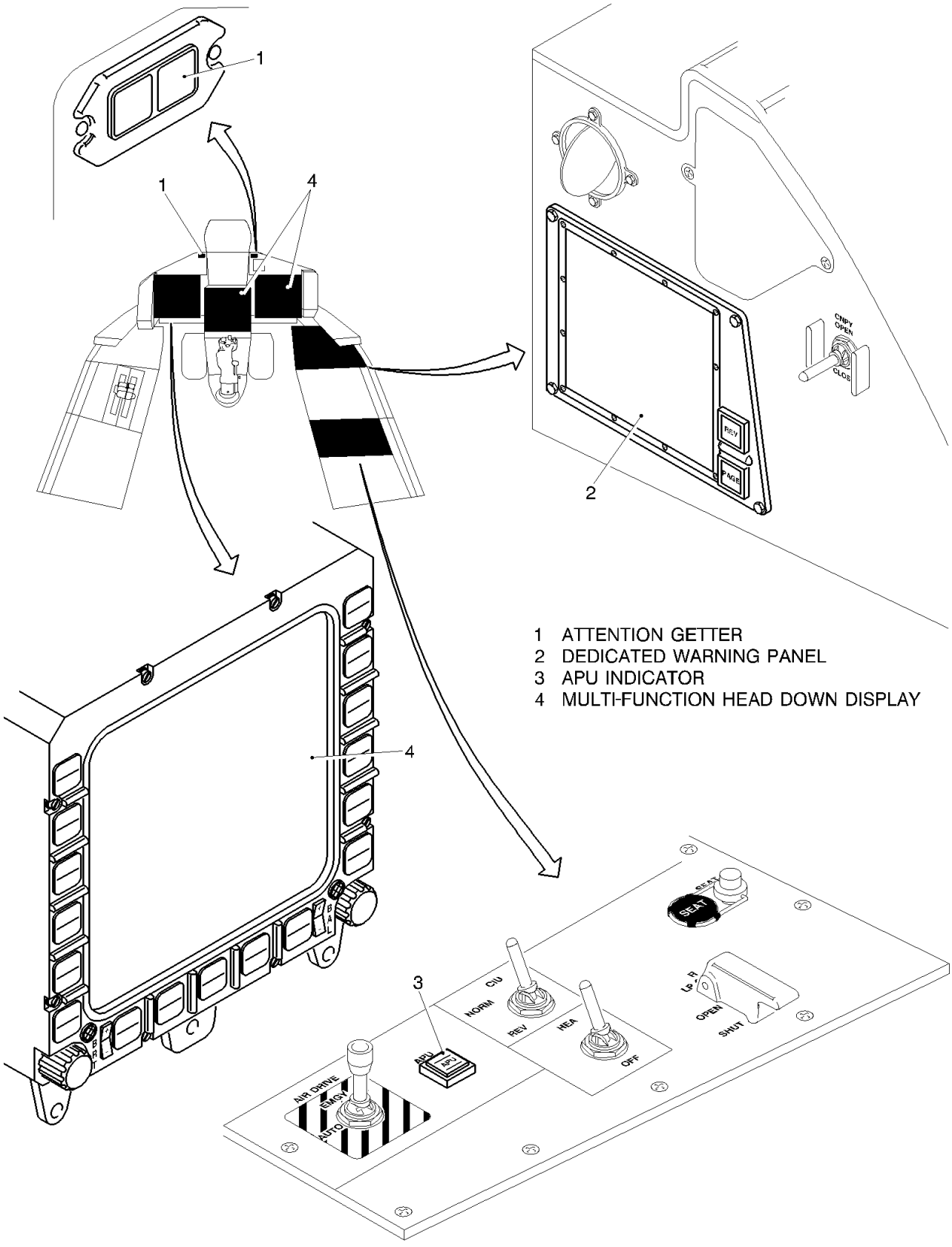
APU START/STOP Switch and Status Indicator

The APU start switch is a three position, momentary action, center biased toggle switch labelled START/ STOP. It is used to initiate the APU start or shut down sequence. The APU status indicator provides an indication of APU availability/operation.



1 ATTENTION GETTER
2 DEDICATED WARNING PANEL
3 APU START/STOP SWITCH
4 APU INDICATOR
5 BATTERY SWITCH (BATT)
6 MULTI-FUNCTION HEAD DOWN DISPLAY

Figure 1.113 - Electrical System Controls and Indicators



1 ATTENTION GETTER
2 DEDICATED WARNING PANEL
3 APU INDICATOR
4 MULTI-FUNCTION HEAD DOWN DISPLAY

Figure 1.114 - Electrical System Controls and Indicators (Rear Cockpit)

HIDRAULIC POWER SUPPLY SYSTEM

Hydraulic Power Supply System

(1B-B-29-00-00-00A-043A-A Issue 007)

General

The hydraulic systems provide power to the primary and secondary control actuators and to the utility subsystems.

Hydraulic power is provided by two independent hydraulic systems. Both the left and the right hydraulic systems are supplied from a separate reservoir each pressurized by a hydraulic pump, which is driven by the accessory gearbox mounted on each engine.

The accessory gearboxes are driven either by the relevant air turbine starter motor (ATS/M) fitted on the gearbox, or directly by the respective engine via a Power Take-Off (PTO) shaft. The ATS/Ms may be driven by the APU, a pneumatic ground cart or the a/c engines in case of cross bleed start.

Each hydraulic system is divided into a Flight Control Pressure circuit and a Utility Pressure circuit. The control systems are designed to have leak protection incorporating isolation valves which will automatically close in the event of an external leakage when the reservoir fluid level drops below 5.0 ltr.

The left and the right hydraulic system supply hydraulic pressure to the primary flight control circuit comprising foreplanes, flaperons and the rudder. Therefore, each of the foreplanes, flaperons and the rudder has two independent sources of hydraulic pressure and one system function also as a back up for the other. The reduction of redundancy will however significantly reduce the maneuver capability.

The left and the right utility systems supply hydraulic pressure to the SLATS, while all other secondary flight controls or hydraulic dependent functions, such as the airbrake, the nosewheel steering or the intake cowls are powered by either the left or the right utility circuit. (Figure 1.115).

Redundancy is provided for the landing gear, the wheel brakes and the IFR probe. In the case of a failure of the relevant primary system, the landing gear, the wheel brakes and the IFR probe are powered by the opposite system. Depending on system and the specific failure case automatic switch over to the opposite system is achieved, or the pilot is able to select the opposite system via dedicated cockpit switches.

Left/Right SPS Computer

The two SPS computers form a component part of the utility control system (UCS) and provide an interface with the UCS data bus for control, monitoring and test functions of the hydraulic system and other associated sub-systems.
The SPS computers incorporate Built-In Test (IBIT and CBIT) facilities for preflight checkout, first line diagnostic check and in-flight monitoring. Status and monitoring data are transmitted via the UCS data bus to the MHDDs, the DWP, the MDP and to the Integrated Monitoring and Recording System (IMRS).
Electrical power to the two SPS computers is supplied by the left and right essential bus bars PP3 and PP4. For ground operation, alternative supply directly from the battery supported maintenance bus is available.

Hydraulic System - SPS Control

The SPS computers control and monitor the hydraulic power generation system, and provide all necessary discrete, analogue and data bus signals for control, monitoring and display. Inputs to the SPS computers interface with active transducers which provide information on hydraulic system pressure, (fluid level, temperature, volume, flow and gearbox speed). Electrical elements of the control circuits, such as relays or valves are monitored for correct operation. Outputs provide discrete signals to the control elements such as the utilities isolation valves and the hydraulic depressurization valves. Information is sent on the data bus to the cockpit displays (MHDDs, DWP) and to the MDP for recording of maintenance data and indicating status of the hydraulic system.

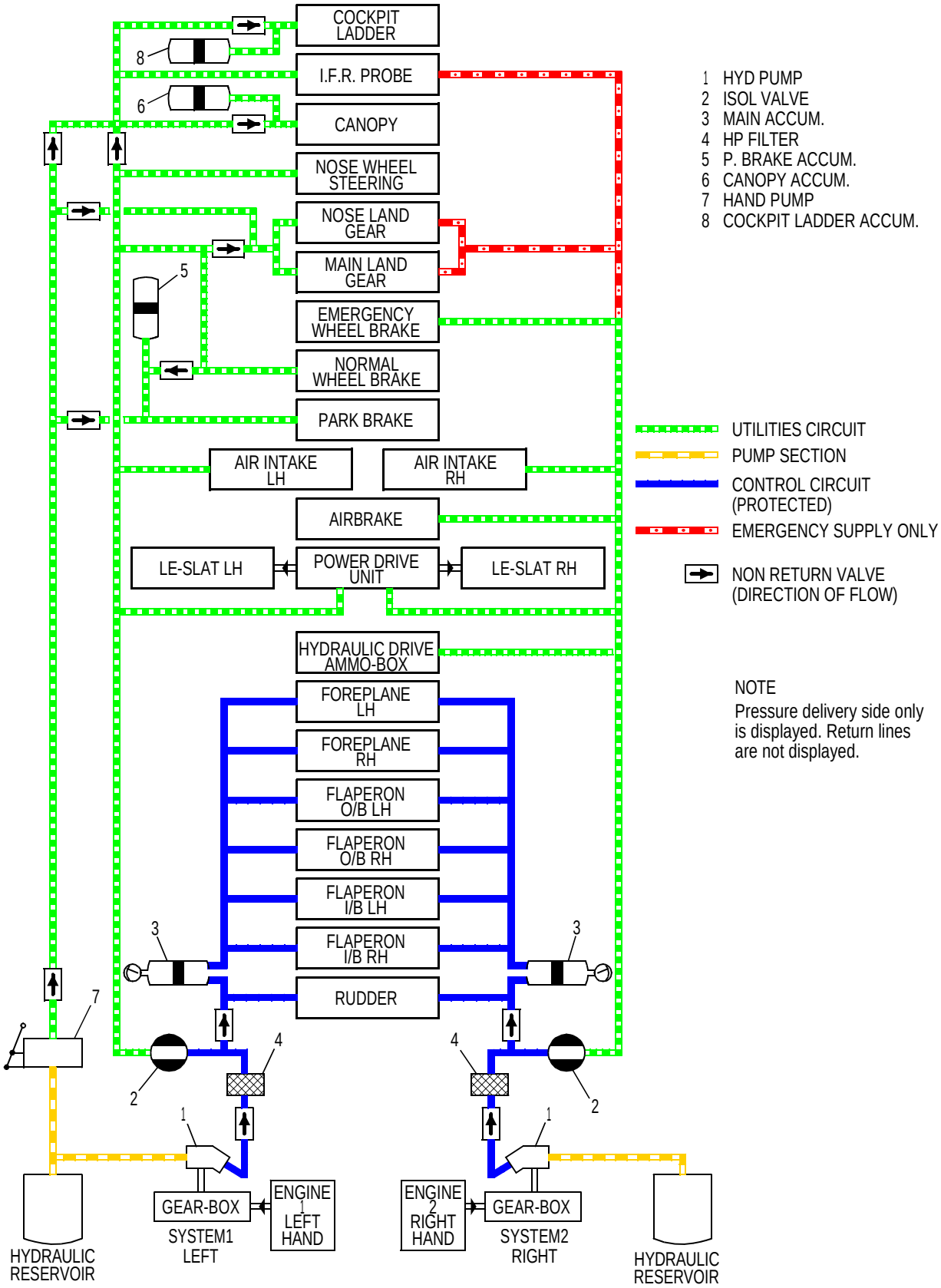


Figure 1.115 - Schematic of the Hydraulic System

Hydraulic System - Main Components

(1B-B-29-10-00-00A-043A-A Issue 008)

General

The hydraulic system provides power to the primary and secondary flight control actuators and to the utility sub-systems.

Hydraulic Fluid Reservoirs

Two reservoirs, one for each system, are located in the rear fuselage. Each reservoir has a maximum hydraulic fluid capacity of 14 liters and incorporates a fluid level transducer, an overboard pressure relief valve, a manual and an automatic bleed valve, a low level switch for Catastrophic Failure Warning (CFW) and a medium level switch for utility isolation interlock override.

Hydraulic Pumps

The two constant pressure variable delivery pumps, one for each system, incorporate a solenoid operated depressurizing valve which is automatically controlled by the SPS computers to reduce gearbox resistance during engine start. When the valve is de-energized system pressure is maintained at approx. 280 +/-3.5 bar at zero flow and 260 bar min. at max flow. In flight, the depressurization suppression relays are activated, i.e. system depressurization is inhibited.

NOTE

There are hard wired interlocks within the valve control logic which prevent both pump depressurization valves from being in an OPEN position at the same time. This condition may arise in case of an incorrect output of the SPS computer following a common mode software/hardware failure resulting in an inadvertent control of systems.

Hydraulic Accumulators

The main accumulator in each control system smooths out pressure surges from the pump and produces the flow response necessary for satisfactory operation of the flight controls. In addition these accumulators supplement pump flow during extreme demands and provide hydraulic power for a limited control capability to assist safe pilot ejection following a double hydraulic power generation failure (Catastrophic Failure Warning). The available time span for safe pilot ejection depends on FCS flow demand.

The left system comprises also a canopy accumulator, a parking brake accumulator and a cockpit ladder accumulator for on ground operation of the canopy, the parking brake and the mechanical locking and unlocking of the ladder door after engines shut down. The accumulators are charged with helium. Information on gas pressure in the canopy respectively main hydraulic system accumulator (nitrogen) is indicated on the MDP.

Isolating Valves

NOTE

The L/R <UTIL P> warning is displayed when the UTIL pressure is below 140 bar in either system or when the reservoir fluid level drops below 5 liter (1.3 liter respectively).

The electrically operated UTIL ISOL valves are automatically controlled by reservoir level information via the SPS computers. With the EMGY GEAR switch in the NORM position the UTILS ISOL valve is commanded to CLOSE if the reservoir level drops below 5 liter. Following an EMGY GEAR switch DOWN selection the demand for valve closure is generated below 1.3 liter to allow complete LDG emergency lowering. Manual operation by the pilot is possible. For moding of the UTILS isolation valves refer to Hydraulic System pag. 1-217.

Hydraulic Cooling

Each system is provided with a Fuel Cooled Oil Cooler (FCOC) installed in the low pressure return line to the reservoir. Incorporated in the FCOC is a bypass valve which is open when the hydraulic fluid is below 60 to 50 deg C to improve hydraulic fluid warm up characteristics.

Hand Pump

A hand operated pump is provided in the left system for recharging the park brake, the canopy and cockpit ladder accumulators. The pump is located in the left accessory gearbox compartment and is operated by a detachable handle. The hand pump is also used to provide on ground operation of the flight refuelling probe and rigging of the landing gear.

Hydraulic Supply

The hydraulic system (Table , “Hydraulic Supply,” on page 1-217) provides hydraulic power to operate the following flying controls and utilities:

Hydraulic Supply

LEFT SYSTEM (SYSTEM 1)	RIGHT SYSTEM (SYSTEM 2)
Primary Flight Control System L/H & R/H Foreplanes L/H & R/H I/B & O/B Flaperons Rudder	Primary Flight Control System L/H & R/H Foreplanes L/H & R/H I/B & O/B Flaperons Rudder
Secondary Flight Control System Leading Edge System L/H Air Intake Cowl Nosewheel Steering (NWS)	Secondary Flight Control System Leading Edge System R/H Air Intake Cowl Airbrake
Utilities Main Landing Gear Nose Landing Gear Wheel Brake Normal Mode Park Brake Canopy In Flight Refuelling Probe Onboard Cockpit Ladder Hydraulic Equipment	Utilities Main Landing Gear - Emergency Extension Nose Landing Gear - Emergency Extension Wheel brake Reversionary Mode In Flight Refuelling Probe - Emergency Extension Linkless Ammunition Box Hydraulic Drive

Hydraulic System

(1B-B-29-00-00-00A-111A-A Issue 007)

General

Monitoring of the hydraulic system is achieved by a combination of built-in monitoring hardware and SPS computer software. System monitoring, display information and maintenance information is provided by the MHDDs, DWP and MDP.

Controls and Indicators

Hydraulic System Status Display

Pressure transducers and temperature transducers provide analogue signals to the SPS computers which form part of the UCS. The SPS computers process specific data for the HYD format display.

Information of specific hydraulic system failures is also indicated on the Dedicated Warning Panel (DWP) and on the MHDD. Related warning captions are presented either as CAT 2 (red), CAT 3 (amber) or CAT C (catastrophic) warnings.

The DWP warnings and associated audios are suppressed on ground during engine start-up cycle and engines shut down when below 55% gearbox speed.

MHDD Hydraulic Format Display

The HYD format gives a diagrammatic presentation of the hydraulic system. It provides a digital readout and an analogue indication of various physical parameters. Symbology is used to present the utilities isolation valve (UIV) status. Red infill is used to indicate warning or failure conditions. Amber is used to indicate abnormal conditions. Green lines indicate correct or satisfactory conditions.

Refer to MHDD - Formats (Colored MHDD format).

MHDD Control

There is no automatic display of the HYD format in any phase of flight modes (POF). Selection of the MHDD soft key (SK) labelled HYD enables to display the actual status of the left and right hand hydraulic systems, when required.

When selected the SK HYD legend is boxed. Pressing the key again reverts the display to the previous (default) format.

MHDD Hydraulics Format-SK Control

When the HYD format is selected, SKs for operation (excluding BLANK ones) are as follows:

– Bottom line: FUEL, ENG, HYD (boxed), WPT and FREQ

– Left side from top: W, BLANK, BLANK, AUTO/MAN (AUTO boxed), BLANK, ELEV

– Right side from top: NORM, Blank, AUTO/MAN (AUTO boxed), HUD, STOR

Utilities Isolation Valve (UIV) Operation

Automatic Operation

NOTE

When AUTO is selected (boxed) the SKs OPEN/CLSD are not available.

Normal position (default) of both, the left and the right Utilities Isolation Valves would be open and the respective soft keys (SK) to display AUTO/MAN with AUTO being boxed. In addition AUTO is displayed on the MHDD next to the UIV symbol for each system.

If the reservoir fluid level drops below the 5 ltr threshold (either system), or 1.3 ltr (RH system 2) in the case of left utilities failure and EMGY GEAR DOWN selection, the computer automatically will close the isolation valve. A hysteresis in the control of the ISOL valve will prevent the valve from oscillating due to fluid returning to the reservoir. The hysteresis is set to 7 ltr, i.e. if the reservoir fluid level raises above 7 ltr, the ISOL valve is automatically opened again.

AUTO selected and following specific failure scenarios, it is possible for the SPS computer to close both UIVs with the appropriate indications on the HYD format and associated warnings.

Automatic Isolation Valve Selections & Indications

SINGLE OR DOUBLE UTILITIES FAILURE			
UTILS CIRCUIT	OPPOSITE UTILS CIRCUIT	UIV VALVE STATUS	OPPOSITE UIV STATUS
1ST FAILURE	2ND FAILURE	SK INDICATION	SK INDICATION
No Fail	No Fail	AUTO OPEN	AUTO OPEN
		AUTO-MAN (AUTO boxed)	AUTO-MAN (AUTO boxed)
S/W Fail	No Fail	AUTO CLOSED	AUTO OPEN
		AUTO-MAN (AUTO boxed)	All SK legends occulted, not available for selection
S/W Fail	S/W Fail	AUTO CLOSED	AUTO OPEN
		AUTO-MAN (AUTO boxed)	All SK legends occulted, not available for selection
UTILS Fail	No Fail	AUTO CLOSED	AUTO OPEN
		AUTO-MAN (AUTO boxed)	All SK legends occulted, not available for selection
S/W Fail	UTILS Fail	AUTO OPEN (re-opened)	AUTO CLOSED
		All SK legends occulted, not available for selection	AUTO-MAN (AUTO boxed)
UTILS Fail	UTILS Fail	AUTO CLOSED	AUTO CLOSED
		All SK legends occulted, not available for selection	All SK legends occulted, not available for selection

Manual Operation

It is also possible to select either one or both UIV to MAN by selection of the respective SK AUTO/MAN. MAN would be boxed on selection and MAN displayed on the format next to the UIV. Selection of

MAN will then display the SK (s) legend OPEN/ CLSD with OPEN boxed (Figure 1.116).

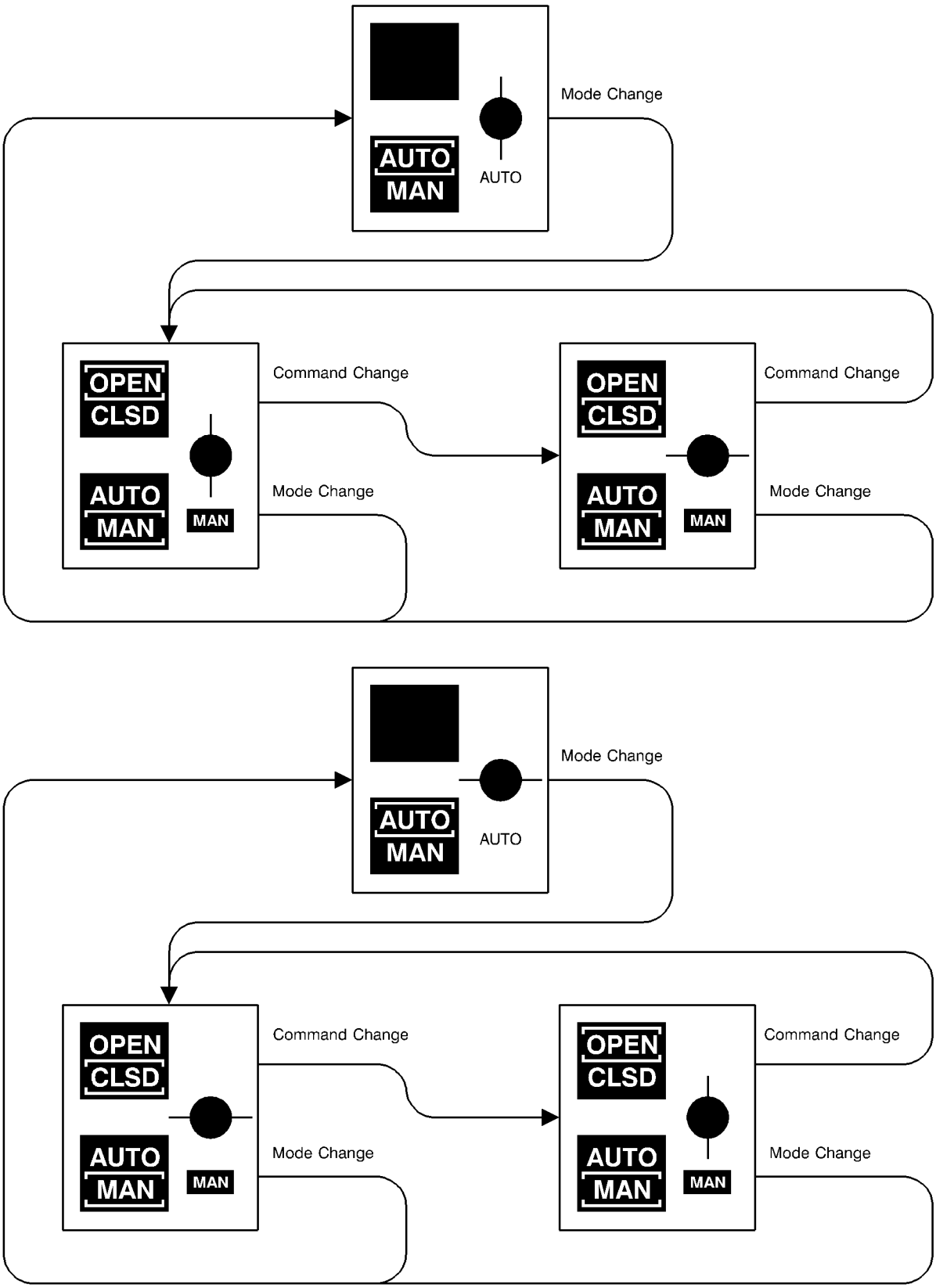


Figure 1.116 - MHDD/HYD Format - SK Moding

NOTE

It is not possible to manually select both UIV to the closed position.

If subsequently to a MAN selection the SK OPEN/ CLSD (OPEN boxed) is operated, the selected UIV will close (CLSD boxed) and MAN remains displayed next to the respective UIV. This will have the effect that the OPEN/CLSD and AUTO/MAN SKs of the opposite system will occult, i.e. these SKs are no longer available for selection. The open system will revert to AUTO with AUTO displayed next to the UIV. Any single or double utilities failure will override the manual selection and revert the control to the SPS computer.

With one valve manually closed and one open, if the currently closed valve is subsequently manually re-opened, i.e. both open again, the AUTO/MAN SKs for both systems are displayed indicating their respective status.

DWP & MHDD/W Indication

The following CAT C, CAT 2 and/or CAT 3 warning captions are displayed on the DWP and the Warnings format following specific failure conditions:

HYD TOT total loss of hydraulics (GUH)

CFW FAIL GND POF only, indicates a failure of the hardwired warnings generation/ suppression system (no GUH warning).

L CONT P or **R CONT P** loss of hydraulic system pressure and/or loss of reservoir fluid (NORM & GUH). The warning (s) caption is accompanied by the warníng **REV ENV**

L UTIL P or **R UTIL P** loss of utilities system pressure and/or the loss of reservoir fluid

L HYD T or **R HYD T** overtemperature condition of either the left or the right system

L HYD A or **R HYD A** excessive air in hydraulics (GND POF only)

LANDING GEAR SYSTEM

Landing Gear System

(1B-B-32-00-00-00A-043A-A Issue 006)

General

The landing gear system is divided into the following subsystems:

- Landing gear functional system (extension and retraction system, sequencing and indication system, struts, tires, wheels and landing gear computer).
- Steering control system
- Brake control system
- Brake chute system
- Arrestor Hook System.

The landing gear (LDG) is a tricycle type, with one nose gear and two wing mounted main gears. The main landing gear (MLG) and the nose landing gear (NLG) consist of telescopic, oleo-pneumatic, two stage shock struts, each having a single wheel. The main wheels are equipped with a brake assembly. The activation part of the nosewheel steering system is integrated in the nose gear leg.

Normal extension and retraction of the landing gear is electrically controlled and hydraulically operated by the left utility hydraulic system. If the left utility hydraulic system fails, emergency lowering of the landing gear is hydraulically operated by the right utility hydraulic system in connection with a set of restrictors inside the MLG and NLG uplocks. The changeover from the left to the right utility hydraulic system (emergency) is induced by a pilot selectable hardwired cockpit control.

Nose and main landing gear bays are closed and locked by hydraulic operated doors. Down locks, uplocks, door locks and struts are equipped with proximity sensors which are linked to the landing gear computer (LGC).

The nosewheel steering is electrically controlled and hydraulically operated by FCS command via the flight control computers (FCCs).

The brake system has duplex hydraulic supply with integrated skid control systems in both, normal and emergency modes. An independent park brake system, hydraulically operated by electrical selection and an additional cooling fan are part of the system.

Indications/information of systems status and warnings are provided via HUD, MHDD, DWP and by audio voice warning.

Landing Gear Control

The landing gear system is controlled and monitored by the landing gear computer (LGC), which provides also an interface to the utilities control system (UCS). The LGC performs control, interfacing, monitoring and test functions for the landing gear system, brake and anti skid system, the arrestor hook system and brake chute system. This includes:

– LG sequencing
– LG indications
– Weight on wheel
– LG emergency lowering
– Brake and anti-skid monitoring function
– Park brake and arrestor hook monitoring function.

The LGC consists of two fully separated systems for control and monitoring of the normal and the emergency landing gear operation. The left system (system 1) is connected to the essential DC busbar PP3, while the right system (system 2) is connected to the essential DC busbar PP4. This ensures optimum mechanical and electrical separation of both systems.

Main/Nose Gear

(1B-B-32-05-00-00A-043A-A Issue 005)

Main Gear

The wing mounted main landing gears retract inboard into the wing root and center fuselage. A hydraulically operated wheel brake and a wheel speed transducer are mounted inside each wheel axle of the main landing gears.

During retraction and lowering the integrated telescopic strut with its oleo pneumatic strut shock absorbers are mechanically compressed to shorten the gear lengths during retraction.

Hydromechanical uplocks hold the main gears in the retracted position. Upon down selection, hydraulic pressure of more than 105 bar will release the uplocks again. In the down position, the main gears will lock mechanically without assistance from the hydraulic systems. Unlocking will be initiated by hydraulic pressure.

Each main gear bay is closed by two doors, one fuselage mounted door and one wing mounted door, which is mechanically linked to the gear legs. The main landing gear doors and the doorlocks are hydraulically operated and automatically sequenced by the position of the main gear.

Electrical proximity sensors indicate gears uplock and downlock, doors open and closed position, and weight of wheel (WOW) condition on each shock absorber. An independent sensor provides the down and locked position under emergency conditions. The sensors are connected to the landing gear computer (LGC) and energized when the landing gear computer is powered up. A BIT (CBIT and IBIT) integrated in the LGC monitors all sensor junctions.

Nose Gear

The nose gear is part of the tricycle landing gear system. The single wheel retracts backwards into the nose gear bay. The nose gear is equipped with a functional unit comprising nosewheel steering selector and motor, shimmy damper, servo valves and various other sensors.

The telescopic strut has an integrated two stage, oleo pneumatic shock absorber.

Prior retraction of the nose gear, the wheel will be centered mechanically when the strut is fully extended, the NWS has automatically disconnected and the wheel is within 20 degrees from the centered position. In the retracted position, the nose gear is stored in the nose gear bay and locked by hydromechanical uplocks.

Upon DOWN selection the uplock will unlock by hydraulic pressure for normal and emergency extension. In the DOWN position, the nose gear is locked by a telescopic locking mechanism which will hold the NLG in a centered position. The mechanism is unlocked hydraulically.

When the NLG is extended, the door is kept to the open position by hydraulic pressure. The locks are released by hydraulic pressure for normal and emergency extension.

When the NLG is retracted, both the NG and the door are hydraulically locked in the UP position. The door actuation and unlocking is sequenced automatically with the NLG leg actuation.

Proximity sensors indicate NLG uplock/downlock, closed, locked and open position of the NLG door, extended condition of the shock absorber and the centering of the nose wheel. Each sensor is connected to the landing gear Computer (LGC). A BIT (IBIT and CBIT) integrated into the LGC monitors all sensor functions.

Landing Gear Emergency System

(1B-B-32-31-00-00A-043A-A Issue 005)

The emergency lowering system is supplied by the right utility hydraulic system and is independent of the normal operation. In the case of left HYD or UTILS system failure automatic changeover to the right HYD/UTILS system will occur.

The changeover from the left to the right utility system may also be initiated via a cockpit selectable emergency gear control switch (EMGY GEAR). When the switch is selected to the DOWN position, irrespective of the position of the LG selector lever, pressure is routed to the combined gear and door

selector valve which is hardwired to the emergency gear control switch in the cockpit, thus bypassing the landing gear computer (LGC). Monitoring of the hardwired circuit for switch position and failure indication via the LGC is still available.

WARNING

- SELECTION OF DOWN WILL LOWER THE LANDING GEAR IRRESPECTIVE OF THE POSITION OF THE LANDING GEAR LEVER.
- FOLLOWING SELECTION OF EMGY GEAR TO DOWN, SELECTION OF RSET WILL RETRACT THE LANDING GEAR, IRRESPECTIVE OF AIRCRAFT WEIGHT ON WHEEL SWITCHES, IF THE LANDING GEAR SELECTOR LEVER IS IN THE UP POSITION.

NOTE

LDG emergency extension dumps about 3.5 liter of fluid from the RH system reservoir to the LH system reservoir.

With EMGY GEAR selected to DOWN, the combined selector valve supplies pressure to the MLG doors and NLG door and gear systems, e.g. locks and actuators. Emergency sequencing is achieved via timing restrictors located in the MLG and NLG uplocks. Sequencing of the NLG leg will be made after full opening of the NLG door via an integrator in the NLG uplock.

Gear and door actuators, as well as gear uplock and doorlock actuators are equipped with shuttle valves to permit changeover from the left hydraulic system (normal lowering) to the right hydraulic system (emergency lowering).

If the landing gear is supplied from the right utility hydraulic system, due to loss of the left utility system, nosewheel steering will not be available. Brakes and anti-skid (normal & emergency), control and monitoring is available through the landing gear computer.

The landing gear systems have duplex electrical redundancy. Control and monitoring of the left and right hydraulic systems are separated within the landinggearcomputer.

Wheel Brake System

(1B-B-32-43-00-00A-043A-A Issue 004)

Wheel Brake

Each main landing gear wheel is equipped with an electronically controlled and hydraulically operated carbon brake.

Brake pressure is supplied by the left utility hydraulic system for normal operation and by the right utility hydraulic system for back-up (emergency) operation.

The changeover from the left to the right utility hydraulic system is either achieved by manual selection of a cockpit controlled two position switch, or automatically, in case of left system failure (detected by CBIT or IBIT).

An anti-skid control system is integrated in both the normal and the emergency wheel brake systems.

An electrical integrated cooling fan, which is operated by wheel speed, brake pressure and WOW inputs, is also controlled by the landing gear computer (LGC) and keeps wheel brake temperatures low.

Pilot demanded brake pedal pressure is controlled independently by the left and right brake pedal transducers. The transducers convert pilot brake pedal inputs into two redundant electrical isolated signals. These signals are routed to the LGC which in turn provides overall independent control and monitor of the landing gear system, including the brake- and anti-skid control subsystem.

The hydraulic pressure to the brakes from either hydraulic system is controlled by two brake and anti-skid control manifolds according to LGC demand.

A brake shut off valve is included in both left and right hydraulic systems to isolate each system from the relevant failed system when required.

When airborne, the LGC closes both shut off valves, thus brake pressure cannot be applied at touchdown to the wheel brakes. The relevant shut off valve (normally for the left system) will open after touchdown by weight on wheels and by a wheel spin-up signal, allowing braking of the main wheels. When airborne, an automatic braking function of the main wheels decelerates the wheels during retraction from 170 Kts to 0 Kts within 1.0 sec. Thereafter the brakes are released again.

NOTE

Loss of LGC processors results in shut off of the servo valve control, which will be de-powered to a safe condition. Normal and/or emergency braking is possible, however anti skid function is lost. Control and monitoring of brake pressure applications is lost as well.

Normal and emergency maximum supply brake pressure is 280 bar.

Park Brake

A park brake, electrically selected via a cockpit switch and hydraulically operated by the left hydraulic system, operates to both wheel brakes. With ON selected and aircraft weight on wheels, Max pressure (280 bar) to the left and right wheel brakes are applied.
The park brake accumulator for brake operation is charged with nitrogen and the pressure (70 bar) is indicated on the MDP. A hand pump for charging both, canopy and parking brake accumulators is provided for the left hydraulic system.

Anti Skid System

(1B-B-32-43-13-00A-043A-A Issue 004)

The aircraft wheel brake system is equipped with an electronically controlled and electro-hydraulically operated anti-skid system. The system is part of the brake and anti-skid control equipment comprising the landing gear computer (LGC) with inputs from wheel speed transducers, pedal transducers, brake and anti-skid manifolds, servo and shut off valves. The system is designed to give individual wheel skid control operation.
The system provides the following functions in both modes (normal and emergency) of operation:

– Touchdown protection
– Brake and anti-skid proportional control
– Locked wheel protection
– Failure detection

The anti-skid system is controlled, monitored and tested by the LGC and is available in the normal and emergency mode of wheel brake operation. For this purpose the LGC consists of two fully separate systems for control and monitor of the normal and emergency wheel brake and anti-skid system. Power supply for the normal operation is supplied by essential DC busbar PP3 and for the emergency operation by essential DC busbar PP4.
The system is energized and automatically tested by a built-in test (CBIT) function when the gear is down or via MDP BIT (IBIT) initiation. Only a failure of both systems (normal and emergency) during IBIT or CBIT will induce a Cat 3 DWP caption (A SKID).
The LGC is receiving electrical signals, proportional to the main wheel rotation speed from two identical duplex wheel speed transducers. The computer detects changes in wheel deceleration and reduces fluid pressure to the servo valves via a combined brake and anti-skid control manifold. For normal operation, the LGC is controlling and monitoring a brake and anti skid control manifold which comprises all valves for normal brake and anti-skid function:

– An electro-hydraulically controlled brake pressure servo valve ensuring anti skid control.
– A wheel brake shuttle valve for normal and parking brake operation.
– A cockpit controlled electrical shut off valve connecting the wheel brake and anti-skid system to the left hydraulic system.

For emergency operation, the LGC is controlling and monitoring a separate brake and anti-skid control manifold which comprises all valves necessary for emergency brake and anti-skid function:

– An electro-hydraulically controlled brake pressure servo valve ensuring brake and anti-skid control.
– A cockpit controlled electrical shut-off valve connecting the wheel brake and anti-skid system to the right hydraulic system.

The wheel brake and anti-skid systems provide touchdown protection, thus preventing braking until weight is on both main wheels and they have spun-up, regardless of brake pedal application. The anti skid system is inoperative below 9 kts GS.

Landing Gear System

(1B-B-32-00-00-00A-111A-A Issue 006)

Landing Gear Selector Lever

The landing gear (LDG) selector lever is on the left quarter panel and comprises a straight control shaft, which incorporates an integral uplock sleeve control and a circular handle, incorporating two red indicators for gear and door unsafe conditions. The landing gear selector lever is only available in the front cockpit of the twin seat aircraft
The function of the gear selector lever when positioned to UP or DOWN (marked on the panel surface), is as follows:

– Position from DOWN to UP:

  • In flight, upwards rotation of the selector lever will select the UP position. This will initiate the LDG retraction sequence, unless RSET has not been selected

subsequent to an emergency DOWN selection via the Emergency Gear Control.

- Physical movement of the selector lever from the DOWN position to the UP position is prevented with aircraft weight on wheels. The facility to allow emergency retraction on the ground, via the dark miniature momentary push-button, is not possible due to the missing nose wheel centered signal to the LGC.
- Upon selection to UP, two red indicators will be illuminated to indicate the unlocking of the LDG doors and legs, and the three greens will extinguish.
- With UP selected, operation of the landing and taxi lights are inhibited, irrespective of the selected position of the Landing/Taxi Light Control.

– Position from UP to DOWN:

- When unlocked, downward rotation of the selector lever will select the DOWN position and will initiate the extension sequence.
- Physical movement of the lever from the UP to the DOWN position is prevented by the uplock sleeve/detent. The sleeve must be withdrawn from its detent to unlock the lever from the UP position and allow downward rotation.
- Upon selection of the DOWN position, two red indicators will be illuminated to indicate the unlocking of the LDG doors and legs. These indications are integral to the selector lever handle and will remain until all doors and legs are locked down. Doors and legs locked down are indicated by the green indicators illuminating and the three Ds in the HUD.
- With DOWN selected, operation of the landing and taxi lights is available under the control of the Landing/Taxi Light Control.

Emergency Gear Control

The emergency gear (EMGY GEAR) cover-guarded, three position toggle switch is located on the forward left hand console. The three positions are labelled RSET, NORM, DOWN, marked on the panel surface.

– With NORM selected, the landing gear is under control of the LG selector lever.

– With DOWN selected the landing gear extends regardless of the LG selector lever position. After a LG emergency DOWN selection, normal UP operation is inhibited unless RSET has been selected.

Refer to Cockpit Layout pag. 1-10.

WARNING

FOLLOWING A DOWN SELECTION, SELECTION OF RSET WILL RETRACT THE GEAR IRRESPECTIVE OF AIRCRAFT WEIGHT ON WHEELS IF THE GEAR LEVER IS IN THE UP POSITION, AND THE RELEVANT HYDRAULIC SYSTEM PRESSURE (SYSTEM 1) HAS BEEN RESTORED AGAIN.

When RSET is selected, the landing gear will be positioned according to the selector lever position.

Landing Gear Display

System indications are given on a dedicated position indicator on the Left Quarter Panel (LQP) and on the HUD.

Landing Gear Status Display

Three identical green circular displays are arranged on the left hand quarter panel above the LDG selector lever. Upon selection of the LDG lever to the DOWN position and/or selection of the EMGY GEAR control to the DOWN position, the left display element will be illuminated as the left main gear attains the down and locked position. Similarly, as the nose gear and right gear are locked down, the center and right indicators are illuminated respectively.

While the landing gear is in transit, the two red displays in the LDG selector lever indicate unlocking or transit of the gear doors and legs or gear(s) and/or door(s) not locked.

Head up Display

Individual indications for each landing gear leg, whether it is locked up (UP), locked down (D) or travelling (X) and LDG doors are not locked, are displayed on the right bottom of the HUD-PDU. Symbols are displayed for 5 seconds after wheels are UP and locked and doors locked.

The format is as follows:

UP	UP	UP
-X-	-X-	-X-
D	D	D

– UP indicates respective gear uplocked and door closed.
– The bar indicates respective gear leg or door position unsafe.
– A X breaks the bar as long as the gear legs/ doors are in transit.
– D indicates respective door fully open and gear downlocked.

The landing gear HUD display is occulted 10 sec. after weight is off the nosewheel.

Landing Gear Warnings

Landing gear warnings (attenson and voice) depend on phase of flight (POF) and are not accompanied by special MHDD and/or DWP warning indications.
The following voice warnings are triggered:

– GEAR TRAVEL — CAT 4 (all except GND) plus flshing “GEAR” on HUD, when 290 KDAS are exceeded, but less than 320 KDAS.
– LANDING GEAR CAT 1 (all except GND) plus flashing “GEAR” on HUD, when LDG not lowered below 180 KDAS, below 500 FT RAlt and both throttles are set below ~ 65 NL.
– GEAR LIMIT (CAT 1 (all except GND) plus flashing “GEAR” on HUD, when 320 KDAS are exceeded with LDG DOWN.

DWP

No dedicated landing gear warning captions are available for display on the DWP. An amber or red NWS caption, depending on the POF (FCS function) will be displayed on the DWP in case of left hydraulic or utilities systems failure.

Brake and Anti Skid Control

Cockpit control of either brake system is provided by a two position, bi-stable toggle switch, labelled EMGY BRK, NORM-REV on the left hand quarter panel.

– With NORM selected, the brakes operate on the left hydraulic system as long as no failure condition is detected. If the left system fails (detected by CBIT or IBIT) the LGC automatically selects the right utility hydraulic system. Anti-skid protection is available.

– With REV selected, the brakes operate on the right utility hydraulic system (emergency brake system). Anti-skid protection is available.

Brake and Anti-Skid Display

System indications are given internally on the ACUE format and externally on the MDP.

External

Brake wear indicator, two on each side on the inner side of the left and right brake unit, protrude above the face of the unit and give information of the brakes status.
Tire pressure gages are installed on each main- and on the nosewheel.

MDP

Brake pressure is logged on the MDP as well as brake and anti-skid system status and the cockpit brake switch position.

MHDD

The ACUE format enables to monitor the progress and results of CBIT and IBIT. A failure of either brake system is indicated on the ACUE format.
Refer to Multifunction Head down Display pag. 1-88.

DWP

BRK FAIL	GND & APP/LDG POF
BRK FAIL	T/O POF
A/SKID	APP/LDG POF
A/SKID	GND & T/O POF.

Park Brake System

A PARK BRK OFF-ON toggle switch (Front Cockpit only) when set to ON selects the parking brake provided weight is on wheels. The parking brake is independent of anti-skid function. With OFF selected, both brakes are released.
If the PRK BRK is selected to ON and advancing either throttle to beyond appr. 60% NL, or when selected ON during the approach/landing phase (landing gear DOWN) a CAT 1 warning is initiated.
The MHDD/ACUE displays a prompt <PARK BRAKE> for the pilot to select the park brake to “ON”. The indication is occulted when the park brake is set to “ON”, or when park brake is selected to “OFF” after engine start.

ARRESTER HOOK SYSTEM

Arrester Hook System

(1B-B-32-90-00-00A-043A-A Issue 004)

The arrester hook system can be used to decelerate the aircraft to a stop by engaging an arrester cable in a rejected takeoff or emergency landing situation.

The arrester hook system consists of a shock absorber, an arrester hook uplock and release unit, and the hook with its arm. The arrester hook is electrically controlled. It extends by gravity and an oleopneumatic shock absorber, and is retracted manually by the ground crew.

The arrester hook release pushbutton controls the extension of the arrester hook. When the pushbutton is pressed, electrical power is applied to the uplock unit to release the arrester hook. The arrester hook assembly is forced down by the combined action of the shock absorber force and the hook weight.

The uplock unit includes a microswitch which detects the arrester hook status and puts the pushbutton light on when the arrester hook is not up and locked. The microswitch signal is also used by the utilities control system (UCS) to generate a warning on the dedicated warning panel. If the hook is not stowed and locked and the arrester hook release pushbutton has not been pressed, the HOOK DWN caption will come on.

If an electrical failure is detected in the arrester hook system, the HOOK caption will come on. This indicates that the hook may fail to function.

To prevent inadvertent unlocking during servicing and when the aircraft is parked, a ground safety pin is provided for insertion in the hook shoe. The ground safety pin must be removed prior to flight.

Arrester Hook Release Pushbutton/Indicator

The illuminated pushbutton, labeled HOOK, is located below the left MHDD and is protected by a concentric raised guard. The guard is black and yellow striped.

When the pushbutton is pressed, electrical power is applied to the uplock unit to release the arrester hook. The pushbutton is always illuminated when the arrester hook is not stowed and locked.

Arrester Hook Warnings

On the dedicated warning panel, the following captions are presented:

HOOK DWN (CAT 2 - red during GND, T/O, APP and LDG, CAT 3 - amber during NAV and COMB) Indicates that the arrester hook is not stowed and locked without having pressed the arrester hook release pushbutton.

HOOK (CAT 3 - amber) Indicates an electrical failure in the arrester hook system. The system may fail to function when it is operated.

In addition the arrester hook failures are accompanied by attention getters and the corresponding "hook down" or "hook fail" voice warning message.

BRAKE CHUTE SYSTEM

Brake Chute System

(1B-B-32-80-00-00A-043A-A Issue 005)

The brake chute system provides additional aircraft deceleration to that provided by the wheel brakes, reducing the landing roll and decreasing tyre and brake wear.

The brake chute system consists of a main chute and a drogue chute packed in a fabric bag and stowed in a compartment in the aft fuselage at the base of the rudder (between the two end turbine nozzles). The compartment is equipped with a door, spring-loaded to the open position.

The drogue chute is spring loaded to assist its deployment into the airstream. It is released by opening the door through the action of a two-position handle in the cockpit.

A riser with a strop fitting connects the brake chute to the brake chute lock and release unit on the aircraft. The brake chute lock and release unit holds the chute strop fitting safely in position during flight by means of twin spring loaded jaws independent of the main lock jaws. The latter are normally in the open position. In case of inadvertent chute deployment (by an action other than movement of the brake chute handle) the twin spring loaded jaws are not able to withstand the loads caused by the parachute, and the chute strop fitting is released with no structural damage to the aircraft.

A break link is provided in the brake chute linkage, to protect the fuselage structure from excessive loads imposed by brake chute deployment at high speeds.

Brake Chute Handle

The brake chute handle, located outboard of the left glareshield (see Figure 1.117), controls the operation of the brake chute. On pulling the handle, electrical power is supplied to the brake chute lock and release unit in order to close and lock the main lock jaws and to open the chute door. As the chute door opens, the drogue chute spring is released and ejects the drogue chute into the airstream. Wind action on the drogue chute pulls the brake chute free of the deployment bag and clear of the aircraft.

Pushing the handle to the forward position removes the electrical supply from the brake chute lock and release unit. This opens the main lock jaws and allows the chute loads to separate the chute from the aircraft.

To prevent inadvertent operation, the handle is equipped with a locking device that locks the handle in both positions. The locking device is operated by a locking lever, which unlocks the handle when is pulled. The both sides of the lever must be pulled at the same time in order to unlock the brake chute handle.

Chute Warning

On the dedicated warning panel, the following caption is presented:

CHUTE	(CAT 3 - amber) Indicates an electrical failure in the brake chute system. The system may fail to function when it is operated.

The CHUTE caption is accompanied by attention getters and the "chute fail" voice warning message.

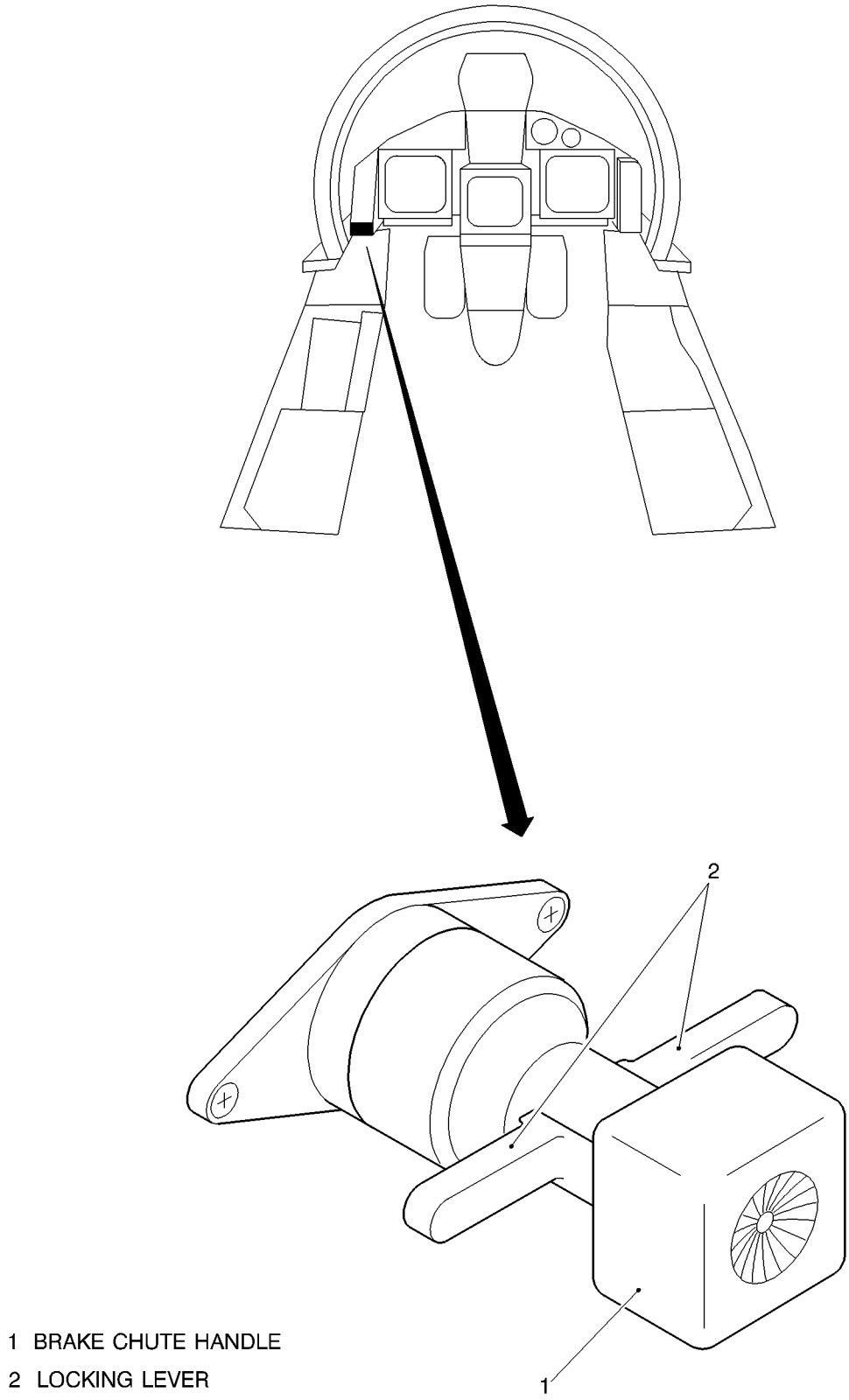


Figure 1.117 - Brake Chute Handle

FLIGHT CONTROL SYSTEM

Flight Control System

(1B-B-27-00-00-00A-043A-A Issue 006)

General

The Flight Control System (FCS) is a quadruplex digital fly-by-wire system with no facility for reversion to mechanical controls.

The FCS is designed to provide the pilot with excellent handling characteristics throughout the cleared flight envelope and to allow Carefree Handling without risk of departure or overstress. As a result EF2000 is an extremely pleasant aircraft to fly which is highly resistant to departure whilst maintaining a high degree of agility.

The control surfaces through which the FCS acts upon the airframe are shown in Figure 1.118.

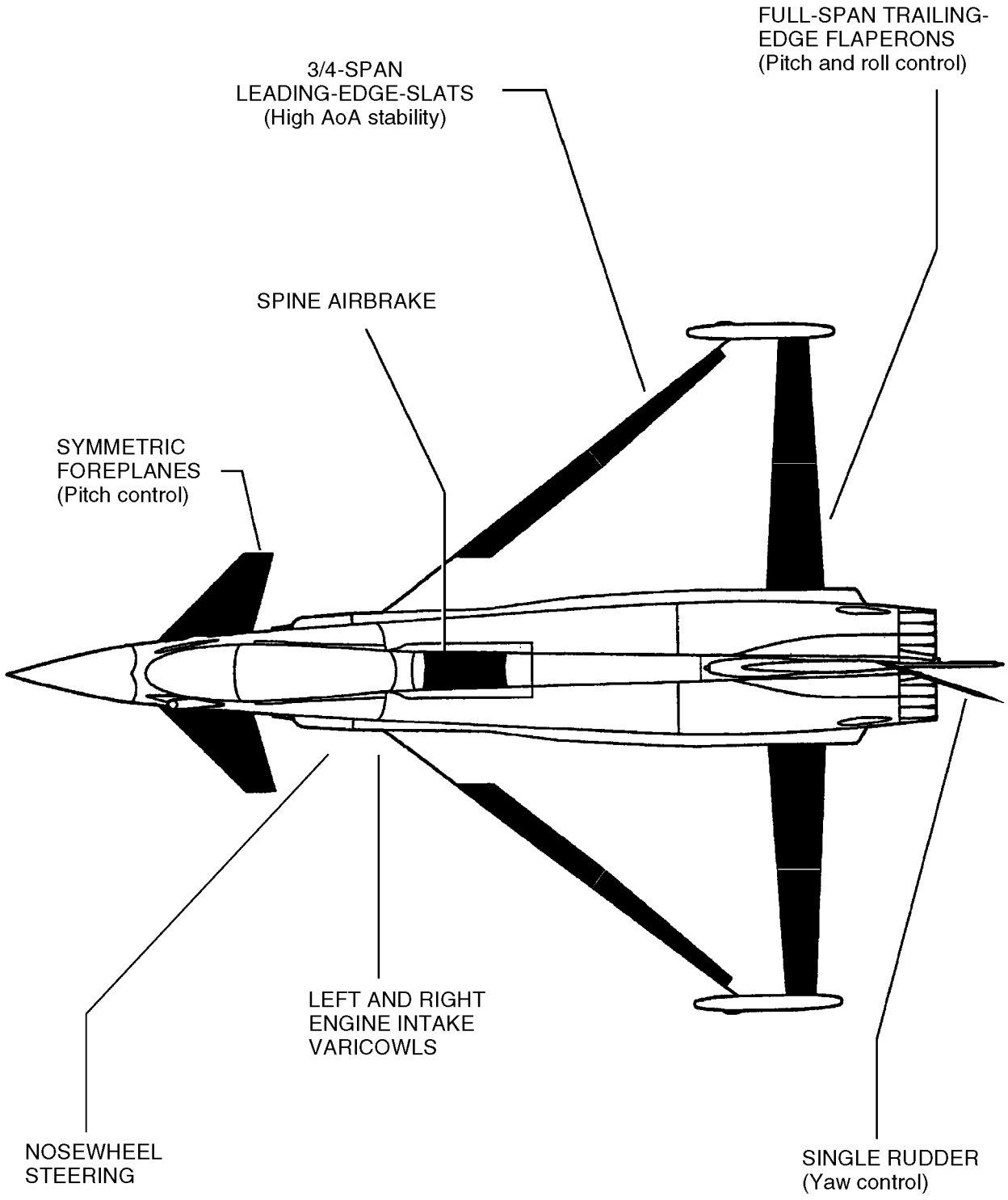


Figure 1.118 - Primary/Secondary Control Surfaces

Aircraft Configuration

The aircraft is a highly unstable delta wing configuration, the FCS controls the inherent instability and provides the pilot with conventional responses to demands. The engines provide the aircraft with positive SEP throughout the majority of the 1g flight envelope. The delta wing planform results in a significant drag rise as speed reduces. The instability allows for good agility sub-sonically and good turning performance super-sonically.

Equipment Integration

Electronic Equipment

– 4 Flight Control Computers (FCC)
– 1 Inertial Measurement Unit (IMU)
– 4 Air Data Transducers (ADTs)
– 2 Digital Engine Control Units (DECUs, not FCS)

Pilot Inceptors (SS/TWS)

– 1/2 Stick Sensor and Control Assembly (SSICA)
– 1/1 Pedal Sensor Unit (PDU), TWS 1 PSU
– 2/4 Throttle Boxes (not FCS)

Primary Flight Control Surfaces

– Foreplane for pitch control and trimming
– I/B & O/B Flaperon; four trailing edge flaperons for pitch/roll control and trimming.
– Rudder to yaw control, trimming and automatic turn coordination.

Secondary Flight Control Functions

– Leading Edge System (LEAS)
– Airbrake
– Left & Right Air Intake Cowls
– Nose Wheel Steering Control System.

Integration

The flight control system is implemented and integrated around a set of four identical and interchangeable, digital flight control computers (FCCs). Each FCC is controlling a lane of the system, including a STANAG 3910 bus, thus providing redundancy for all critical functions. Each FCC is also acting as a bus remote terminal, where two FCCs are interfacing with the avionics system bus (AVS) and the other two with the utilities control system bus (UCS).
Quadruplex electrical and duplex hydraulic redundancy is available for the primary actuators, incl. the LEAS, while the other secondary actuators have simplex electrical and hydraulic control.
The air data system (ADS) comprises four ADT and DECU/IMU derived airdata as back up.

Electrical power is supplied to each FCC and IMU lane from two independent 28V DC protected bus bars, PP3 and PP4. The FCS is designed that the four lanes operate synchronously. This is achieved by synchronizing the digital channels between the FCCs. Refer to Figure 1.119.

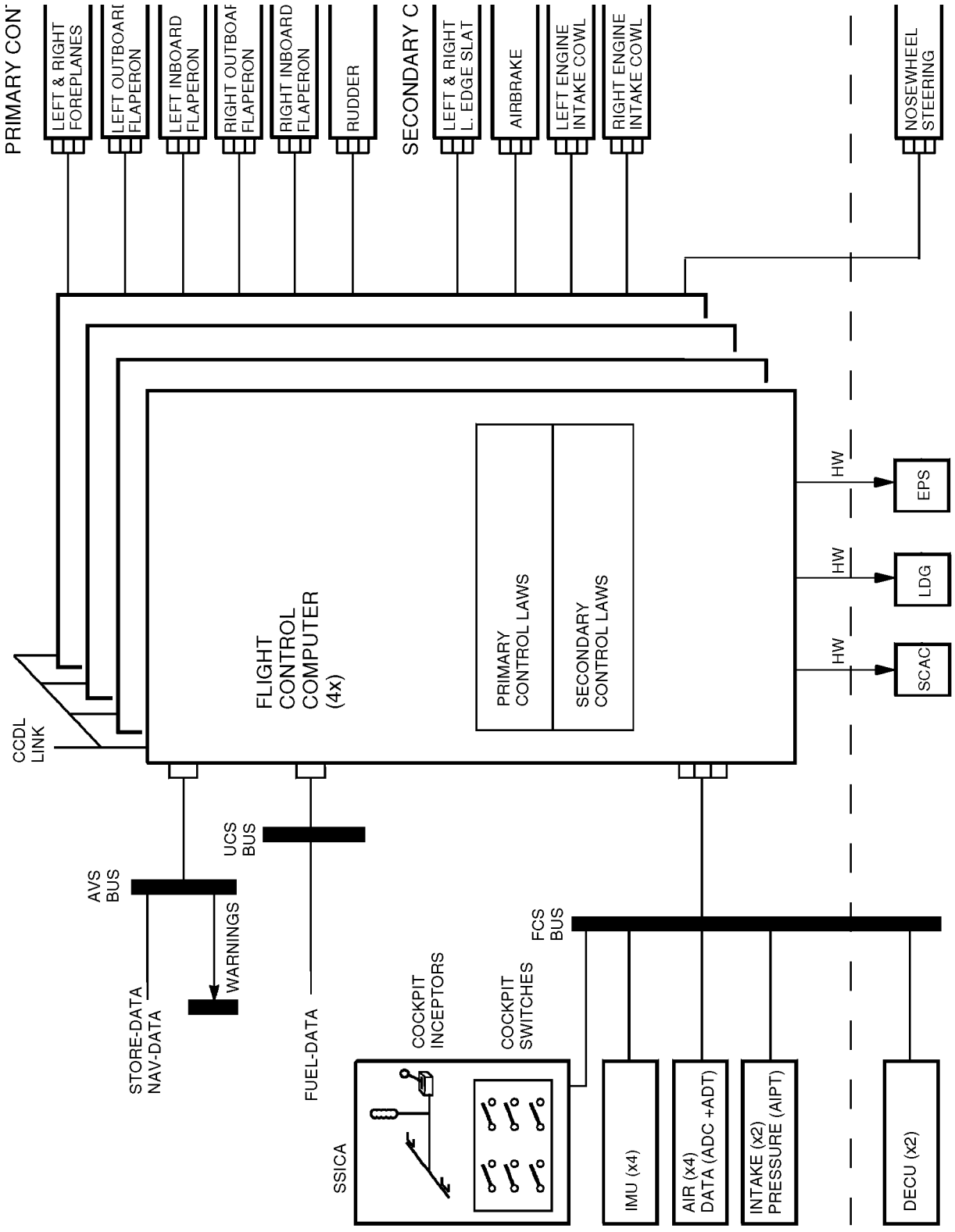


Figure 1.119 - FCS/FCC Integration

Inertial Measurement Unit (IMU)

The IMU outputs are:

Aircraft motion (inertial sensed):

- Angular rates (pitch, roll and yaw rate)
- Accelerations (normal, lateral and longitudinal)

Aircraft Attitudes:

- Pitch angle
- Bank angle.

Calculated Data:

- True heading
- Estimated altitude and vertical velocity
- Estimated air data (TAS, incidence and sideslip)
- AOA and SS are compared internally with ADT values.

The IMU inputs are:

Latitude and True Heading (Nav data for alignment only)
Pressure Altitude, True Airspeed
Aerodynamic Incidence and Sideslip
FCS Status and Command Words.

FCS FPSP1a Functions

The following functions are implemented:

- Operative leading edge
- Full FCS mode & Automatic Reversionary FCS mode
- Approach trim schedule (FP +2° LEAS 0°)
- NWS with minimum turn circle (+/- 48°)
- Carefree maneuver, all axes, to the FPSP1a loading targets CG symmetric configuration
- Carefree A/B operation
- AOA and g protection with landing gear down
- Intake cowl scheduling to production standard
- Store scheduling from SCAC sufficient for external tank carriage and A/A external stores (excluding TMC)
- Mass estimator, requiring availability of fuel/ store sensing signals
- Inclusion of inertial AOA and SS information from IMU Air Data Estimator
- Incorporation of attitude signals to the primary control laws
- Optimized roll/pitch combined handling at extreme roll pilot command
- Flight path hold down to 200 KEAS (= KDAS), LDG DOWN
- Auto-roll Trim including bank hold and heading hold wings leveler
- Pitch/roll prioritization: Automatic reduction of roll rate if flap reaches saturation; prioritize pitch response over roll response, but guarantees a minimum roll rate
- Lift dump fully automatic with mass scheduling
- Lift dump auto-cancelled with NWS in low speed mode (high gain). Foreplanes are moved to DUMP position on 2nd engine shut down
- Autothrottle.

FPSP1a Control Law Functional Performance

General

The FCS will:

- Provide air data and other information both internal and from the digital engine control unit (DECUs) to all aircraft systems via the avionics system (AVS) and utilities system (UCS) buses, in particular, provide the data to the primary cockpit displays and to the Get-U-Home Instruments (GUHI).
- Introduce compatibility with the EJ200 engine.
- Provide Air Data System- (ADS), Inertial Measurement Unit- (IMU) and engine data to Avionics System (AVS) and to the Utilities Control system (UCS).
- Transmit FCS warnings via the AVS bus.
- Provide specific data to the integrated monitor and recording system (IMRS) IPU and to the Flight Test Instrumentation (FTI) system via dedicated unidirectional serial digital links.
- Provide a full test coverage Frequency Bias Input (FBI) facility to allow envelope expansion and air data calibration trials. The functions to be implemented are inputs at actuators only; bias, impulse and single frequency sweep.

Handling Overview

The FCS provides the pilot with good aircraft handling characteristics throughout the cleared flight envelope. The FCS limits aircraft response to ensure loads are maintained within structural limits irrespective of external stores configuration, internal fuel distribution and prevailing flight conditions. The FCS also limits AOA and sideslip ensuring that the aircraft has no potential for departure.

Pitch, roll and yaw demands are blended and limited where appropriate by the FCS to produce good agility and maneuverability in response to effectively “careless” pilot inputs. Aircraft response to pitch inputs can be one of three speed dependent effects; a pitch rate demand, a g demand or an alpha demand, the transition between each features a blending region which is transparent to the pilot. Aircraft response to roll inputs is scheduled with both airspeed and alpha, where prevailing alpha is close to a limiting condition at the time of a large stick input

alpha is reduced in order to ensure adequate roll rate is provided.

Stability Augmentation

The FCC provides aircraft stabilization in all three axis, including automatic scheduling for fuel and store loading.

FCS Primary Laws

The primary control laws are designed to provide a manoeuvre command system using a hybrid pitch rate (q demand) / AOA/g demand control system.

Maneuver Response

The aircraft is fully self trimming in pitch and roll with the landing gear up. Positive and negative AOA/g protection is provided with LDG UP and DOWN, and carefree handling (CFH) is provided with LDG UP.

Control of Aerodynamic Configuration

The trim angle values for foreplane, leading edge surfaces and flaperons are designed to be programmed to achieve an optimum compromise between performance and maneuverability (Figure 1.120).

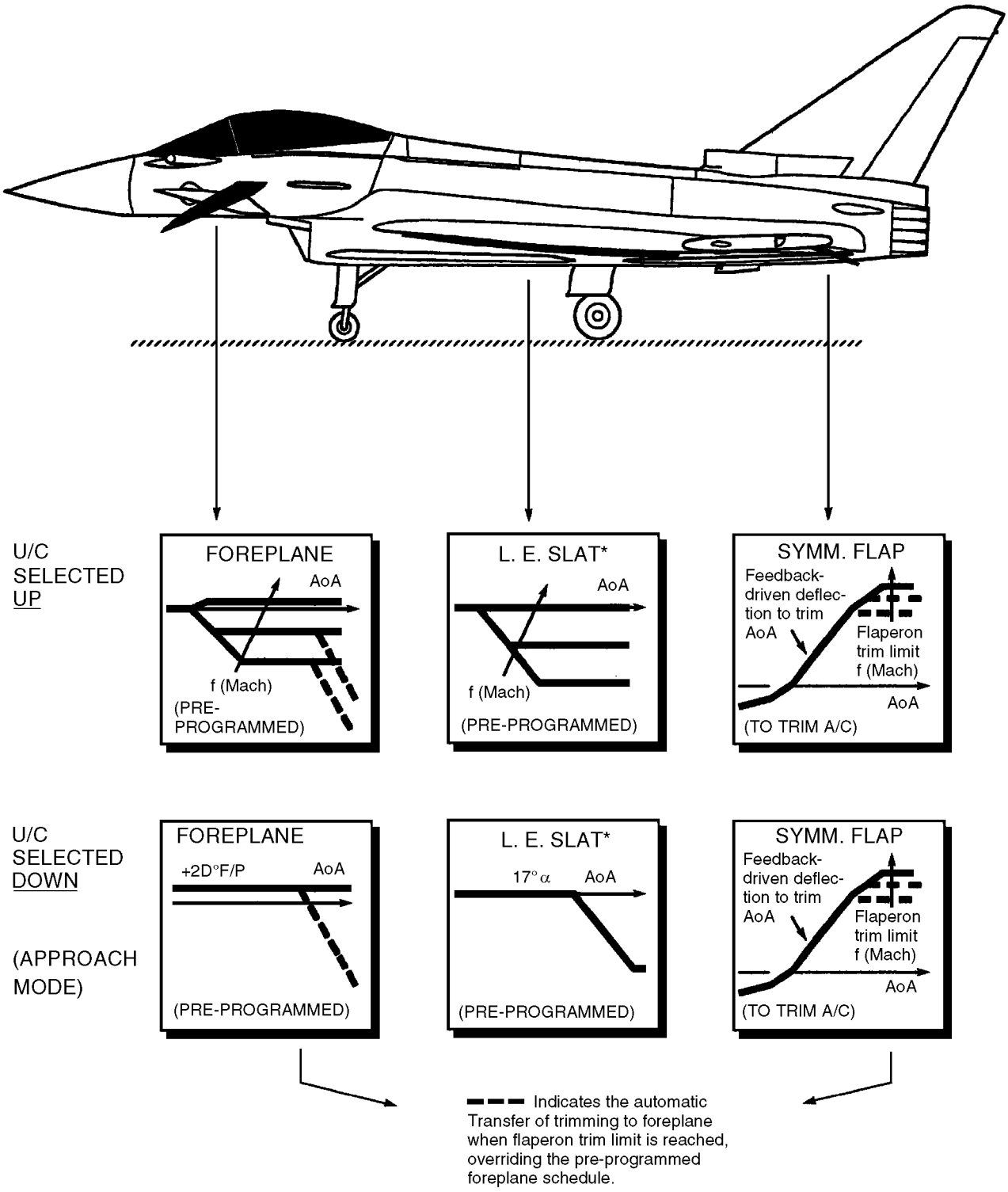


Figure 1.120 - Aerodynamic Control

Emergency g Override

An override capability of the maximum positive g is provided.

Automatic Failure Handling

In the event of a critical FCS failure, the FCS will automatically revert to Reversionary Control Laws (REV LAWS). The FCS REV Laws are engaged for the following anomalies:

– 2nd or 3rd failure of ADT Ps or Pt
– loss of ADT AOA/AOS
– loss of attitudes (2nd failure)

The control laws are protected for the following failure cases:

– loss of fuel data
– loss of stores data
– LEAS failure
– loss of NWS
– airbrake failure.

Pilot observed procedures are provided in the FCC.

Twin Seat Version (TWS)

The FCS control laws for the twin seater are the same, but different performance and limitations than the single seat have to be respected.

Flight Control System (Twin Seat)

(1B-B-27-00-00-00B-112A-A Issue 008)

Cockpit in Command Arbitration

This process configures the FCS to operate either the twin seat “SOLO” or twin seat “TRAINER”. It also provides the arbitration logic to disengage via ICO operation several FCS functions such as AP (from FPSP1b onwards), AT and NWS.

Based on the position of the Priority Cockpit Selector (PIC), located only in the front, the FCS is configured to operate in a SOLO or on a TRAINER (FRONT or REAR) version. In addition it:

– Identifies the priority cockpit, and
– Determines and indicates which cockpit has FCS control or is in FCS command.

Figure 1.121,

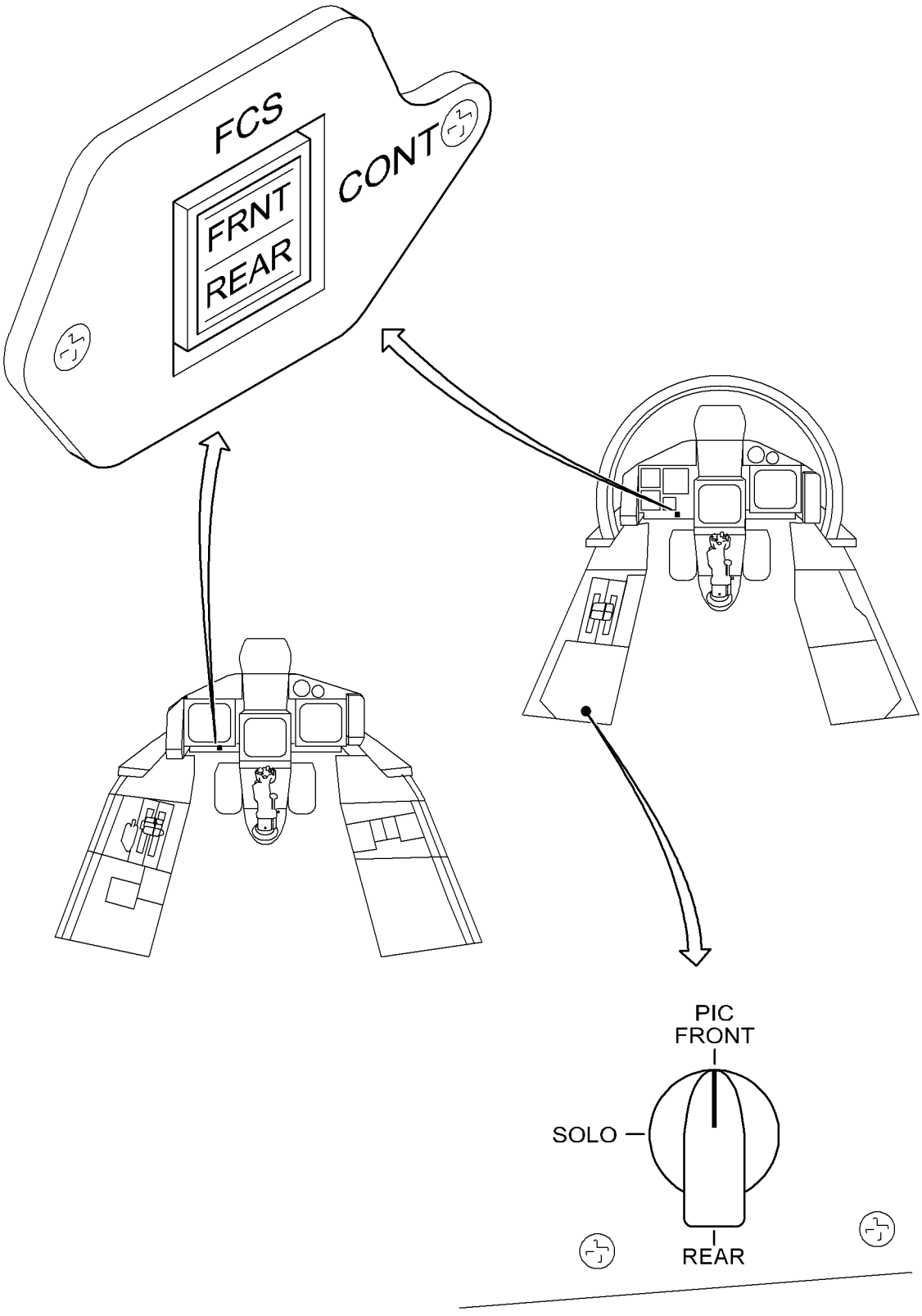


Figure 1.121 - TWS Configuration/Hand over Control

The rudder pedals are mechanically linked and available to both cockpits.
The ACUE format, in both cockpits, displays a prompt to indicate PIC status.
The interlock for selection of priority cockpit configuration are:

– Weight on all Wheels (WOW), and
– No taxi motion detected
– FCS selected mode.

The two methods of obtaining cockpit in command between cockpits are:

– ROUTINE Takeover: is achieved by the operation of the FCS CONT selector/indicator, located in both cockpits. Routine takeover leads to a change of control either from the front to the rear cockpit or vice versa. Pressing the FCS CONT in the cockpit currently under FCS control is ignored. The routine takeover is not available if configured SOLO. Routine takeover with AT engaged will not interrupt any AT operations that was taking place before the takeover.
– RAPID Takeover: is achieved by the instructor pilot, when cockpit is not in command, by pressing the ICO. Once a rapid takeover has taken place, the student can take back FCS control via the routine takeover procedure. The NWS and the throttle follow up functions are not disengaged. The AT is disengaged.

Front Cockpit Functions

The following cockpit functions are only available in the front cockpit (no arbitration):

– On entry into FRS, the control of the FCS defaults to the front seat.
– Engine start and shut down is only available from the front cockpit.
– Normal LDG selection UP/DOWN.
– BARO pressure setting (indication also in rear cockpit).
– FCS TEST (if cockpit in control).

Cockpit In Command Functions

The following functions are with the cockpit in command:

– AT (or FBI)
– Stick pitch/roll and all trims.
– DATUM ADJUST/TRIM switch
– FCS RSET control
– Airbrake IN/OUT
– ICO

Aircraft Configured SOLO

PIC selector (front cockpit) to SOLO.

When the aircraft is configured for SOLO flight, the FCS will be identical to that of the single seat aircraft. All indications will be simultaneously displayed in the rear cockpit. However, FCS related inputs from the rear cockpit, if occupied, will be ignored and the throttle follow-up function will not be engaged in the rear cockpit.

Aircraft Configured Trainer

Two configurations are possible, namely:

– PIC selector to FRONT, or
– PIC selector to REAR.

In this configuration, it arbitrates between Front and Rear Cockpit controls using, in general, the information of “cockpit in command” as arbitration criteria.

PIC FRONT

Stick and throttle demands as well as the operation of other dedicated FCS switches and controls from the rear cockpit, will have no effect on FCS control, however, all indications are provided to the rear cockpit. Throttle follow-up is available.
Operation of the FCS CONT in rear cockpit will result in FCS control being passed to the rear cockpit. Rear cockpit has then full command. The instructor in the front cockpit can always takeover control by either Routine or Rapid Takeover.
As long as the FCS control is with the front cockpit, i.e. FCS CONT-FRNT lit, operation of the ICO in the rear cockpit will have no effect. FCS CONT-FRNT remains lit. Operation of the ICO in the front cockpit will disengage NWS. Pressing the FCS CONT push button in the rear cockpit will transfer FCS control to the rear cockpit. ICO in the front will transfer FCS control back to the front cockpit. A second ICO press in the front cockpit will disengage NWS on ground.

PIC REAR

In this configuration, stick and throttle demands as well as the operation of other dedicated FCS switches and controls from the front cockpit, will have no effect on FCS control. Throttle follow-up is available. The rear cockpit has full command. FCS CONT-REAR is illuminated (except startup phase).
Operation of the FCS CONT in the front cockpit will result in FCS control being passed to the front cockpit. Front cockpit has then full command. The instructor in the rear cockpit can always takeover control by either Routine or Rapid Takeover.
As long as the FCS control is with the rear cockpit, i.e. FCS CONT-REAR lit, operation of the ICO in the front cockpit will have no effect. FCS CONT-REAR remains lit. Operation of the ICO in the rear cockpit will disengage NWS. Pressing the FCS CONT push button in the front cockpit will transfer FCS control to

the front cockpit (FCS CONT-FRNT lit). ICO in the rear will transfer FCS control back to the rear cockpit (FCS CONT-REAR lit). A second ICO press in the rear cockpit will disengage NWS on ground.

Throttle Follow Up

The left and right throttle positions associated with the cockpit not in control move in unison with the left and right throttle positions manually commanded by the cockpit in control.

In the case of a failure of one throttle box a throttle follow up warning is generated (<THROT LK>) and the follow up mode is cancelled.

Temporary Throttle Override

The instructor (priority cockpit) can override throttle control via AT engage button depress and hold (AT is then disengaged). Throttle control is returned to the student once the instructor releases the AT button.

AT Mode

If AT is engaged, the left and right throttle positions in both cockpits move to the rate limited position commanded by the AT function.

System Moding

Weight on Wheels (WOW)

This process uses LDG controlled relays to determine the a/c weight on wheels state. There is only one relay per gear strut/wheel.

Under no failure condition the in air/on ground state of the system is altered according to the nosewheel state (transition to in air/FLT) and nosewheel and mainwheel states (transition to on ground). In the case of nosewheel failures, e.g. jammed on nosewheel or nosewheel signal failures pitch rate or main wheels are used to set the system into the air state (FLT-LATCHED). If this occurs, the transition to ground from the FLT-LATCHED state only occurs based on mainwheel and alpha (AOA).

For redundancy purpose the FCS Pitch Rate from the IMU and the FCS AOA data from the ADS provide additionally improved integrity/detection of failures.

The WOW function in general detects:

– Nose wheel flight latched.
– Nose wheel jammed on the ground.
– Single main wheel failures.
– Incorrect LDG lever position indication.

Ground

In the ground mode, which includes takeoff run until lift-off, landing roll with lift reduction and taxi, the pilot has direct link to:

– Foreplane and symmetric/differential flaperons by use of the stick.
– The rudder and the nosewheel steering by use of the rudder pedals.

On ground, at low a/c speeds the gains in the control law demands to all primary surfaces are reduced to prevent unnecessary activity of surfaces induced by sensor feedback signals when the aircraft operates on bumpy run or taxiways.

Airdata displayed, such as AOA, KDAS/M is set to a valid default value until a speed of 50 KDAS has been reached. From 60 to appr. 80 KDAS the pitch damper signal is fading in.

Transition from Ground to Airborne

After entering FRS and normal LDG hard wired relay operation, the a/c is considered on the ground as long as the WONW relay is set to “TRUE”. As soon as the WONW signal is set to “FALSE” transition into air is initiated.

In the case of additional failure detection, i.e. the NWS relay has failed on transition to air:

– IMU pitch rate plus AOA data are used, or
– Both main LDG WOW are detected “FALSE”, i.e. off the ground.

Airborne

After rotation the weight off the nose wheel initiates and activates the transition sequence to the airborne mode. The fade in is 3 sec. After transition to the airborne mode, maneuver demand control law is active. In addition, the landing gear lever signals LDG up or LDG down FCS mode.

Transition from in Air to on Ground

The transition from the in flight status to the ground status is governed by WONW plus at least one WOMW.

In the case of additional failure detection, i.e. the NWS relay has failed and the nose wheel was set to flight latched (NWS legend on the FCS RSET button flashes), then:

– Both WOMW must be “TRUE” and AOA data from ADS must be available.

If FCS AOA data are not healthy:

– then exit from flight latched is not possible and the DWP NWS warning is set.

Lift Dump

The LIFT/DUMP function provides the ability to reverse the direction of the lift force which generates increased drag and extra load on the mainwheels to aid braking performance. This is achieved by driving the control surfaces into a DUMP position, i.e. flaperons upwards and foreplane leading edge downwards, scheduled via a Lift Dump control law mode.

Moding of the LIFT/DUMP function is fully automatic with no requirement for a dedicated switch operation by the pilot. Foreplanes and flaperons are scheduled with airspeed to assist in decelerating the aircraft. The moding includes also mass scheduling to ensure that Lift Dump operation is within Lift Dump cleared limits.

During low speed taxi, Lift Dump is automatically not engaged to ensure that no foreplane reflection of the landing lights occur. At engine shut down Lift Dump is engaged (DUMP) to ensure that the foreplanes are parked in a position that does not interfere with the ladder.

Lift Dump is engaged:

– with both throttles at idle, a/c above taxi speed and NW on the ground, or
– at engine shut down (to assist actuator parking).

During automatic Lift Dump, pilots stick input commands are still active and will override the flaperons deflections.

Lift Dump is not engaged and TOT is automatically set:

– with at least one throttle above idle, or
– a/c at taxi speed (below 20 kts GS), or
– NW off the ground, or
– a/c mass above landing gear limit.

The lift reduction (DUMP setting) consists of the following stages (Figure 1.122)

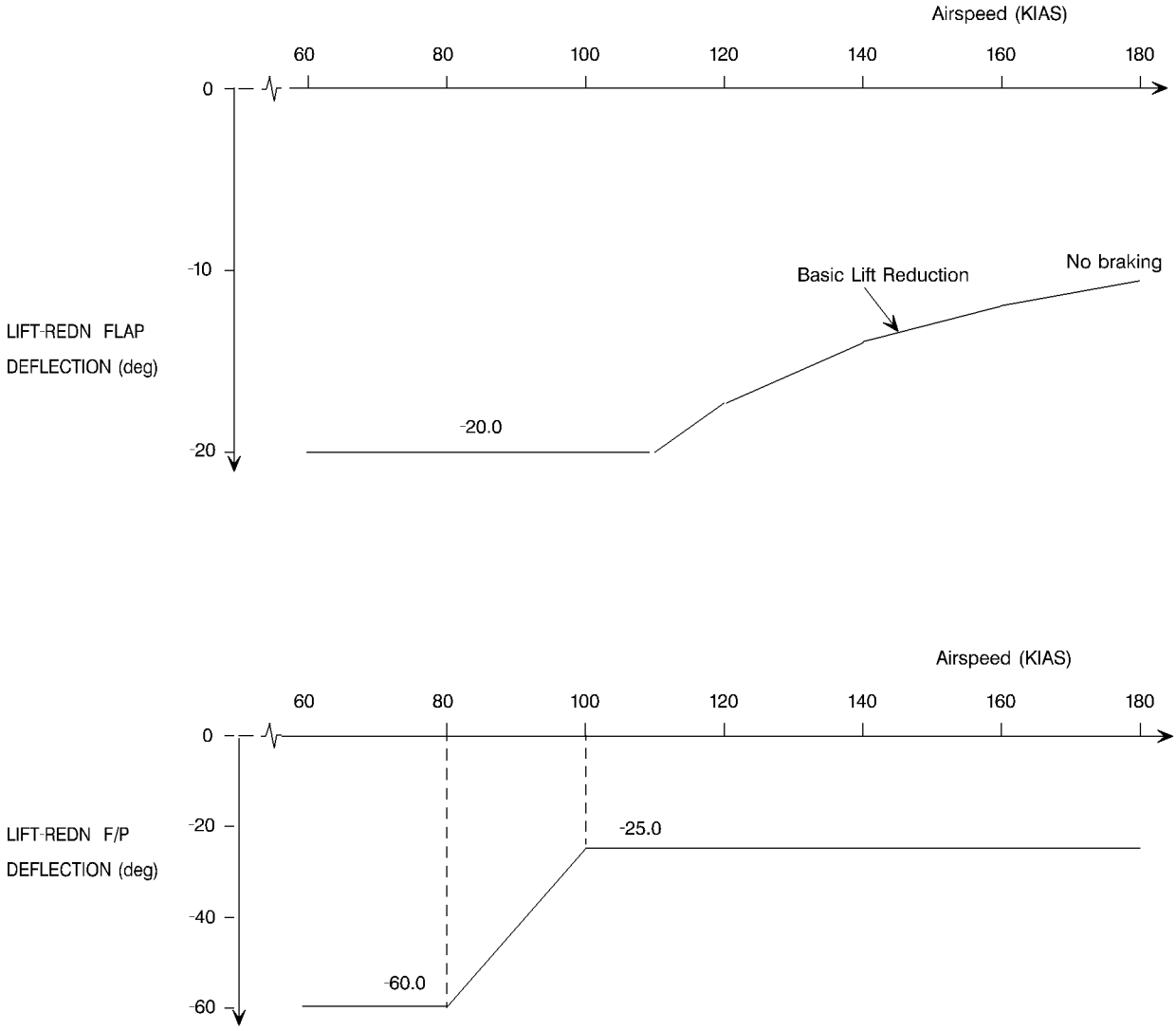


Figure 1.122 - Lift/Dump Schedule

– Pre-set of -25 deg foreplane and an increasing negative flap deflection as airspeed reduces.
– An additional super imposed airspeed/ deceleration scheduled negative flap deflection to a level where flap induced pitch up is balanced by the pitch down provided by brake torque.
– Foreplane rotated from -25 deg to -60 deg below 90 KDAS (max drag).

There is no indication to the pilot as to whether the DUMP mode is engaged other than the control surfaces.

Propulsion

Information of the left and right throttle positions is provided to the left and right EJ200 DECU and to the landing gear and fuel management subsystems. The left DECU is connected to FCC1 & 3 while the right DECU is connected to FCC 2 & 4.

Throttle position is routed from the SSICA interface to the LGC and FCS interfaces and in addition to the left and right DECU interfaces. On ground this routing is dependent on successful IBIT completion.

A throttle follow up function is implemented.

To establish the correct data transfer between the FCCs and the DECUs via the FCS bus, a certain sequence of events must take place as follows:

– FCS PFC takes 20 seconds from FCS power up, during this period no transfer of data between DECU and FCS is performed.
– When the throttles are moved from HP SHUT to IDLE or above, the DECU is commanded to be powered (hardwired signal from throttle box to relevant DECU).
– The DECU needs approximately 2.5 seconds from DECU power up to perform its initialization and IBIT operation. During this period no transfer of data between DECU and FCS is performed.
– Once the correct data bus communication is established, the DECU enters normal operation and data transfer can start.
– Airdata calculations will commence when the aircraft is airborne , or both NH are indication above 50 % NH.

The DECU is powered up when:

– The left and/or the right throttle levers are moved from HP SHUT to IDLE or above, or
– The aircraft is airborne.

The DECU is commanded to shut down, when:

– The left and/or the right throttle levers are moved from IDLE or above to HP SHUT, and
– Engine run down is detected below 50% NH, and
– The aircraft is on the ground (WOW).

Cockpit Switch Moding

FCS RSET Button

Following successful completion of PFC or ACT respectively, entering FRS is only possible from the front cockpit by pressing the FCS RSET button. Simultaneously NWS and TOT are engaged and indicated in both cockpits.

Subsequent operation of this control from either cockpit is possible, however the function is dependent on “who has control”.

Operation of the FCS RSET button causes the FCS to enter flight resident software (FRS), to engage the NWS and to set the takeoff trim (TOT). This is indicated by a low flashing (0.5 Hz) of the NWS, provided LINS is set to NAV mode, and T/O legend steady lit. The control surfaces are normally set to their datum trim position. The NWS will engage if the nosewheel is within 46.8 deg of the centered position, which represents actuator limit.

Under certain FCS failure conditions, the FCS may be reset to a normal failure free state using the FCS RSET button. A reset is only possible if the failure return to a failure free state; in this case the <FCS 1> warning will be accompanied by the <FCS RSET> warning.

Nosewheel Steering (NWS)

This process initiates and executes the moding to engage and disengage the NWS. The moding comprises basically two main modes, namely:

– NWS Pre-Take Off/Landing, and
– NWS Airborne/Approach.

Refer also to Nosewheel Steering pag. 1-249.

The NWS provides a low speed mode (+/- 43°) from 0 speed up to 30 kts, a medium speed mode (+/- 28°) from 30 kts to 60 kt and a high speed mode (+/- 10°) above 60 kts. The modes are calculated based on wheel speed, IN velocities (GS) and throttle position. The blend from the low speed to the mid speed takes place on acceleration through 30 kts GS and from the mid speed to the high speed mode at 60 kts. The blend from the mid speed mode to the low speed mode on deceleration takes place at 20 kts GS.

– On entry into FRS the NWS enters the low speed mode (+/- 43°) and the NWS legend on the FCS RSET button is flashing at a low rate (lift dump not engaged)
– if the LINS has failed the NWS will enter the mid speed mode (+/- 28°) by default, this is indicated to the pilot by the DUMP position

– setting either both throttles close to Max Dry or accelerating the aircraft above 30 kts GS in any throttle position, will cause the NWS to enter the mid speed mode (+/- 28°). At 30 kts GS the NWS legend on the FCS RSET button is steady lit
– decelerating through 20 kts GS the NWS blends to the low speed mode, the NWS legend will start flashing again
– the blend from the mid speed to the high speed mode and vice versa is accomplished when the aircraft is either accelerating or decelerating through 60 KDAS
– When airborne, i.e. no weight on nosewheel, the NWS will be disengaged and the NWS legend extinguishes. On landing, with weight on the nosewheel the NWS legend will be lit again.
– Operation of the ICO on the ground causes the NWS to disengage, the NWS legend to flash, and the DWP <NWS> is raised. Pressing the FCS RSET button will reset the NWS legend, reset the <NWS> warning and re-engage NWS.
– If ICO is selected and the LDG is then selected UP, the NWS legends will cease to flash and the DWP <NWS> warning will extinguish. When LDG is selected DOWN again, ICO is remembered, the NWS legend continues to flash and the DWP <NWS> warning is raised again.
– The free caster mode is entered when NWS CBIT failures are detected. NWS will be disengaged, NWS legend is extinguished and the DWP <NWS> warning is displayed.
– In the case of a NWS failure the NWS will fade to zero by mechanical means and control law demand.

Takeoff Trim (TOT)

This process provides the moding necessary to:

– Provide visual indication of the trim offset status on the ground,
– Allow to reset all trim offsets via the FCS RSET button on the ground,
– Automatic reset of all trim offsets if at least one throttle is advanced above IDLE on the ground.

Weight off the Nosewheel

With weight off the nosewheel the TOT legend is extinguished. Pressing the FCS RSET button will have no affect on trim.

Weight on Nosewheel (WONW)

Upon entering FRS or when in FRS and either throttle is advanced above IDLE the control surfaces are set to the TOT position, indicated by the TOT legend steady lit. The NWS will engage. Manual trim inputs are ignored as long as at least one throttle is out of the idle position.

With both throttles at idle pressing the TOT button will reset the trims, if applicable, to the TOT position.

The TOT position (Take Off Trim) can be manually offset in pitch, roll and yaw causing the T/O legend to flash if the trim offsets are > 0.25 deg of the TOT position. A reset to the datum (T/O steady lit) position is achieved either by:

– Pressing the FCS RSET, or
– Advancing at least one throttle out of the IDLE position.
– Manually re-trimming of all axis to within the TOT threshold of +/- 25°.

Datum Adjust TRIM Switch

The DATUM ADJUST/TRIM switch can be used in two modes as follows:

– The DATUM ADJUST mode is used for inputting datum values for the AP Altitude Acquire and Heading Acquire mode.
– The TRIM mode for making manual pitch and roll inputs to the FCS control laws.

The mode used by the stick top Trim switch is determined by the position of the DATUM ADJUST/ TRIM switch. The normal position of the switch is in the DA position (forward). The TRIM (aft) position is used occasionally when manual trim inputs to the primary control laws need to be made. The switch is time monitored, i.e. the moding provides a monitoring function of the yaw trim switch and the dual purpose stick mounted Trim/AP datum adjust switch, and also provides the resultant trim cancel moding function.

Depending on the switch position the moding controls whether a primary control law input for pitch or roll trim shall be made, or an AP heading or altitude datum entry shall be done via the stick top pitch/roll trim button. The logic of Table on page 1-244 applies.

DATUM ADJUST/TRIM SWITCH POSITION	AP STATE	FUNCTION AVAILABLE	PITCH/ROLL TRIM FUNCTION
DATUM ADJUST	engaged	AP datum adjust	Disabled
DATUM ADJUST	not engaged	AP datum adjust	Disabled

DATUM ADJUST/TRIM SWITCH POSITION	AP STATE	FUNCTION AVAILABLE	PITCH/ROLL TRIM FUNCTION
TRIM	engaged	No function	Disabled
TRIM	not engaged	Pitch/Roll Trim	Enabled

For failure moding logic refer to Datum Adjust/Trim Failure pag. 3-40.

Store Configuration Setting

NOTE

At FCS FPSP1a store group A is set by default on power up.

Store group A uses data from Fuel (mass) and the SCAC of the cleared configuration. Store group A will only be accepted if the initial store data warnings, <SCAC> and/or <FCS MASS> are not set. However, if SCAC fails the data will be set to a safe default position within store group A.

The store configuration selection logic allows to override the Fuel/SCAC derived signals using the CONFIG OVRIDE selector switch according to Table , “Functionality of CONFIG OVRIDE Switch,” on page 1-245. CONFIG A, B or C can only be manually selected with the cover guard open (up). With the cover guard open any of the three selections A, B or C will select the particular store configuration for the control laws. The relevant button is lit, all others are off. The store group illumination is available in the front and the rear cockpit.

NOTE

The configuration setting B and C is not active at FPSP1a&b

Functionality of CONFIG OVRIDE Switch

CONFIG SETTING	STORE GROUP	FUNCTIONALITY
A	1	Fully automatic scheduling. All Fuel/ Store interface signals function as designed.
B	2	All Fuel/Store interface signals are fixed at values representing a/c configuration in CL Store Group 1 at 14 ton.
C	2	All Fuel/Store interface signals are fixed at values representing a/c configuration in CL Store Group 2 at 16 ton.

Baro Pressure Setting

The BARO pressure moding function (BPM) is handled via the left glareshield (LGS) utilizing a toggle switch. The toggle switch (up/down) on the LGS selects the baro pressure values in 1 mb or 5 mb steps upwards and downwards depending on the input selection time. The toggle switch is only available in the front cockpit, but all displays are available in both cockpits. The actual selected baro pressure is displayed by AVS D & C on the LGS via a four digit number in millibars and is also presented on the HUD. The selected baro pressure value is supplied to the airdata process, which delivers the corrected baro altitude. The corrected baro altitude is then displayed to the HUD and the GUH instrument altimeter on the RGS.
The baro pressure pilot selection signals as well as the “ringback” illuminations are routed via CIU and AVS bus to FCC1 and FCC2 and additionally via RGS and UCS bus to FCC3 and FCC4 in order to cover a single source failure. In the case of such a failure the pilot has to select the remaining valid source via the yaw trim switch (reversionary baro pressure selection), and the <BARO SET> warning will be set temporarilly. In the case of a double source failure the standard pressure is set to the last good value and the <BARO SET> warning is permanently raised. refer also to Baro Set Failure pag. 3-39.

The BPM runs in normal FCS mode as follows:

– On a/c power up the BPM is automatically set to standard pressure 1013.
– The pressure can then be altered via the toggle switch in increments of either 1 mb or 5 mb upwards or downwards depending on the input

selection time. The selected baro pressure range is 850 mb to 1070 mb.
- The standard pressure of 1013 can be set by the non-spring-centered left position of the toggle switch. If the control is set back from the standard selected position to the center position the BPM sets the last value which has been entered previously.
- Control inputs (up/down) in excess of 23 seconds will trigger the <BARO SET> warning and restore the last valid baro pressure setting. The control will fail and no further adjustments are possible.

Landing Gear

FCS moding, i.e. landing gear UP or landing gear DOWN, is purely dependent on the landing gear lever position.

The main differences between the control laws LDG UP or LDG DOWN are:

- With the LDG DOWN the longitudinal control system provides reduced g/AOA limits compared with LDG UP.
- With the LDG DOWN the maximum roll rate is reduced and rudder pedal authority is increased.

When the FCS control laws switch from landing gear down to landing gear up laws, the roll rate command gain is increased (and vice versa).

The landing gear DOWN control law mode has the following features:

- Carefree handling is not available; however, an AOA (20°) and g (+4/-0) limiter is available. Roll authority is 80 deg/s.
- Pitch handling is pure pitch rate demand (Q), with AOA feedbacks suppressed to minimize turbulence response.
- Sideslip feedback is suppressed at approach AOA's to minimize turbulence response.
- Foreplane is pre-set to a + 2 deg position, increasing available lift and drag.
- Leading edge slat is fully retracted (0°) within the normal approach AOA range (below 17 deg).
- The low speed artificial static stability is set to its full approach phase level.
- Minimized out of trim on takeoff, with the static stability function cancelled when accelerating to avoid the requirement to re-trim on climb out.

FCS Operational Modes

Full Operating Mode

The FCS full mode includes:

- Valid AOA and SS signals including Total temperature (TT)
- Valid attitude data from IMU-FCC moding (IMU/ LINS)
- Valid Mass/Store data automatic for Store Group A.

Handling Features Subsonic

- Uniform takeoff response over a range of masses and throttle settings, controlled by airdata scheduled ground mode authorities.
- L/G down pitch rate demand mode with AOA and g limiting function.
- Improved lift/increased drag in the approach phase. Airbrake is fully available within the normal approach AOA.
- Carefree with L/G up; loads limits with unrestricted use of stick and rudder > 150 KDAS. The A/B will auto retract outside the airbrake envelope.
- Pitch response transitions to agile for large command inputs.
- Max. g limited to 90%/84% (8.1g/7.25g).
- Roll authority of 80 deg/sec with the LDG DOWN.
- Roll authority with full fuel tanks on is 125 deg/ sec, linearily increasing to 200 deg/sec when tanks are empty.
- Max. roll rated 200 deg/s at low AOA/g above 250 KDAS, LDG UP.
- Above 25 AOA rudder is suppressed.

Handling Features Transonic/Supersonic

- Carefree operation in supersonic area. However, in the transonic region cleared limits are pilot observed.

Command Authority

- Max allowable g (neg & pos) and max AOA overshoot in the subsonic envelope.
- Max roll rate up to 215 deg/sec.
- Max AOA overshoot in subsonic envelope.

Maneuver Demand

- Transition in the 300 KDAS region from g-demand limiting at high speed to AOA demand limiting at lower speed.
- Stick center is pitch rate demand at all speeds above approach speed.

Use of ADS Alpha and Beta

- Used for feedback control and actuator trim scheduling.
- FF-IMU/ADE mixed alpha/beta used for CLAWS.

Reversionary Operating Mode (Automatic Degradation)

The control laws are automatically set to the FCS Reversionary mode via the Airdata System (ADS), if alpha and beta cannot be delivered with the defined accuracy, i.e.:

– An ADT 2nd failure confirmed, ADE is running for further 9 seconds.
– IMU attitude (ADE) 2nd failure, LINS will be back up for 2 minutes.

The REV mode automatically substitutes ADS AOA (α) with derived α when ADS signal fail. The achieved schedule is less accurate since α is estimated rather than measured. ADT derived AOA (α) and sideslip (ß) cockpit displays on GUH are lost and the CAT 2 warnings <FCS REV> and <REV ENV> are displayed. In the event of ADT sensed AoA and sideslip failure the IMU can only provide autonomous AOA & SS for a very limited period of time. Therefore the control laws will revert to reversionary operation after a short period of time.

ADT Second Failed REV Mode

In this mode:

– Alpha and Beta are invalid, AOA display is lost.
– Attitude data are valid.
– Mass & Store data are valid (Store Group A)

IMU Attitudes (ADE) Failed REV Mode

In this mode:

– Alpha and Beta are valid, AOA is displayed.
– Attitude data are invalid.
– Mass & Store data are valid (Store Group A)

General Handling

– Similar to the full FCS system mode
– No carefree handling (clearance)
– Handling in general is departure resistant within subsonic envelope
– Envelope is limited with regard to g/AOA.

Maneuver Demand

– Alpha demand mode is substituted by a g (Nz) demand in REV mode
– Fade of Q-demand at stick center to g (Nz) demand at full authorities.

AOA and SS

AOA and SS are not used within the control laws.

Special Moding Features

In Flight Refueling (IFR)

Upon selection of the IFR probe to out the FCS automatically configures to the IFR mode where the control responses have been optimized for the IFR task. In addition, the air data is no longer sourced from ADTs, but from the DECU 5th source in order to avoid the potential effects of loss or damage to one or more ADTs as a result of contact with the hose or basket.

These control laws have historically been termed “Reversionary” as they are also scheduled when certain failures exist within the FCS or the Air Data System. The normal envelope associated with IFR/ Reversionary laws is 2g/20° alpha. There is a difference in the cleared flight envelope for IFR mode and Reversionary mode. If the FCS degrades to reversionary laws as a result of failure (s) an FCS REV and REV ENV warning are generated and the FCC limitations apply. With IFR probe extended a limited envelope has been cleared which includes an RTB if the probe is stuck out.

NOTE

Following a <L UTIL P> failure condition with the probe selected to OUT, the FUEL PROBE switch must be selected to EMGY OUT to lock the probe again.

AOA & SS

When the IFR Probe is deployed the control laws are automatically set into the FCS Reversionary mode for which AOA and SS are not required. With the retraction of the IFR Probe, IFR mode is cancelled and the control laws return to full FCS laws.

Pressures

The corrected, consolidated and rate limited DECU Pt and Ps are used to produce the airdata parameters when the IFR Probe is deployed.

On approach to the tanker a very restrictive rate limiting is applied to DECU Pt in order to protect against disturbance which are possible in the event of the drogue passing in front of the engine intake.

With the retraction of the IFR Probe or when the IFR switch is set to IN, IFR mode is cancelled and the control laws return to full FCS laws, i.e. ADTs for air data.

Foreplane

(1B-B-27-40-00-00A-043A-A Issue 003)

Two identical all moving foreplanes - also known as canards - are located left and right side of the forward fuselage and are part of the primary flight control surfaces. In-flight, symmetric operation of the foreplanes and flaperons is used to provide pitch control. Max control surface deflection is:

60 deg leading edge down and 20 deg leading edge up.

Two actuators, powered by both left and right hydraulic systems drive the foreplane surfaces. Four electrical independent lanes within the actuators are signal controlled and monitored by the four flight control computers (FCCs). Each lane controls one coil of a direct drive motor (DDM) which controls the position of the main control valve.

The hydraulic flow from the main control valve, derived from the two independent hydraulic systems, drives a tandem ram. Feedback loops are installed measuring ram and DDM displacement for control loop closure.

Electrical failures (first and second) will have no effect on aircraft handling. A failure of one hydraulic system will lead to reduced hinge moment capability.

Flaperons

(1B-B-27-10-00-00A-043A-A Issue 005)

Two pairs of inboard and outboard flaperons fitted to the trailing edge of the wings are part of the primary flight control surfaces. Each inboard and outboard flaperon is driven by actuators powered by both hydraulic systems. Quadruplex electrically independent lanes, controlled and monitored by the four flight control computers (FCCs) operate the actuators mainly by command and stabilization augmentation signals. Each lane controls one coil of a direct drive motor (DDM) which controls the position of the main control valve.

Pitch control is provided by the symmetric operation of the foreplanes and the four flaperons, while roll control is achieved by differential movement of the flaperons. They are scheduled automatically according to the stored control law functions to satisfy all flight conditions, e.g. approach and landing, slow flight, high speed etc. thus providing together with the other primary control surfaces the necessary stability of the aircraft.

Control surface movement of the inboard and outboard flaperons is 20 deg trailing edge up and 30 deg trailing edge down.

Rudder

(1B-B-27-20-00-00A-043A-A Issue 003)

The rudder is controlled through the FCCs which receive pilots commands from the pedal sensor unit (PSU) via the SSICA. Since augmentation of aircraft lateral stability is required, including flight envelope regions where the lateral axis is aerodynamically unstable, the control laws stabilize the aircraft via sensor feedback signals. The four electrical independent lanes within the actuator are signal controlled and monitored by all four flight control computers (FCCs). Each lane controls one coil of a direct drive motor (DDM) which controls the position of the main control valve.

The main control valve is supplied from the two independent hydraulic systems, whose fluid drives a tandem ram. As on other primary control surfaces, electric and hydraulic redundancy is totally independent.

The rudder pedals are also used to generate brake and nose wheel steering signals.

The maximum control rudder movement is 30 degrees left and right. Failure of one hydraulic system will lead to a reduced hinge moment.

Leading Edge System

(1B-B-27-50-00-00A-043A-A Issue 004)

General

The leading edge system (LES) is installed in the center fuselage and wing and comprises one inner and one outer slat on each half of the wing running on tracks. It is part of the secondary control surfaces and is supplied by both utility hydraulic systems. The slats are operating synchronously between 0 deg (UP) and -19.5 deg (DOWN).

The leading edge slats are electrically controlled and hydro mechanically operated and monitored by all four FCCs. Each of the two slat motors (one left, one right) receives power from one utility hydraulic system. Both motors are controlled from a tandem control valve which is driven from a Direct Drive Motor (DDM).

Control Laws

Slats position is computed as a function of air data AOA and Mach number. The slats operate automatically with no provision for manual control. Electrical feedback linkages associated with the slats actuators and the FCCs cause the slats to stop whenever the appropriate slat position is reached. To prevent excessive wear on the LES the control laws include an artificial hysteresis function which provides commands to the output only when the

disparity between required and actual position exceeds a threshold.

Control Law Schedule

The Control Laws contain open loop schedules for all of the secondary control surfaces (airbrake, LEAS, intake cowl). These are defined to satisfy the following criteria:

– Achieve maximum performance from the aircraft
– Maintain adequate control powers
– Keep basic aircraft stability within acceptable limits
– Avoid loading problems.

With the landing gear in the DOWN position the SLATS are locked in at and below 17° AOA.

Slats Asymmetric Protection

The slats on both wings are monitored through an asymmetry detection in the FCCs to identify any significant difference in the position between left and right surfaces. A surface monitor prevents asymmetry difference greater than 3 degrees stream wise, corresponding to 4.6 deg. hinge wise, causing the system to lock the slats at the present positions. The SLATS will continue to operate under the following conditions:

– Any single electrical failure will allow full operation.
– Any single hydraulic failure will allow operation but with reduced load performance.

In the event of any single mechanical failure, i.e. drive shaft breaking, the slats will be locked to a fail/ safe position at the position of the asymmetry and remain inoperative.

DWP

SLATS or SLATS depending on POF, indicating frozen SLATS.

Nosewheel Steering

(1B-B-27-00-10-00A-043A-A Issue 008)

General

The nosewheel steering (NWS) allows the pilot to follow a desired taxi pattern or to keep directional control of the aircraft during takeoff and landing in response to rudder pedal inputs. The NWS is scheduled automatically in response to a combination of airspeed, aircraft groundspeed from LINS and wheel speeds from the landing gear computer.
The NWS is powered by the Left Utility Hydraulic System (UCS) and controlled and monitored by the FCS.

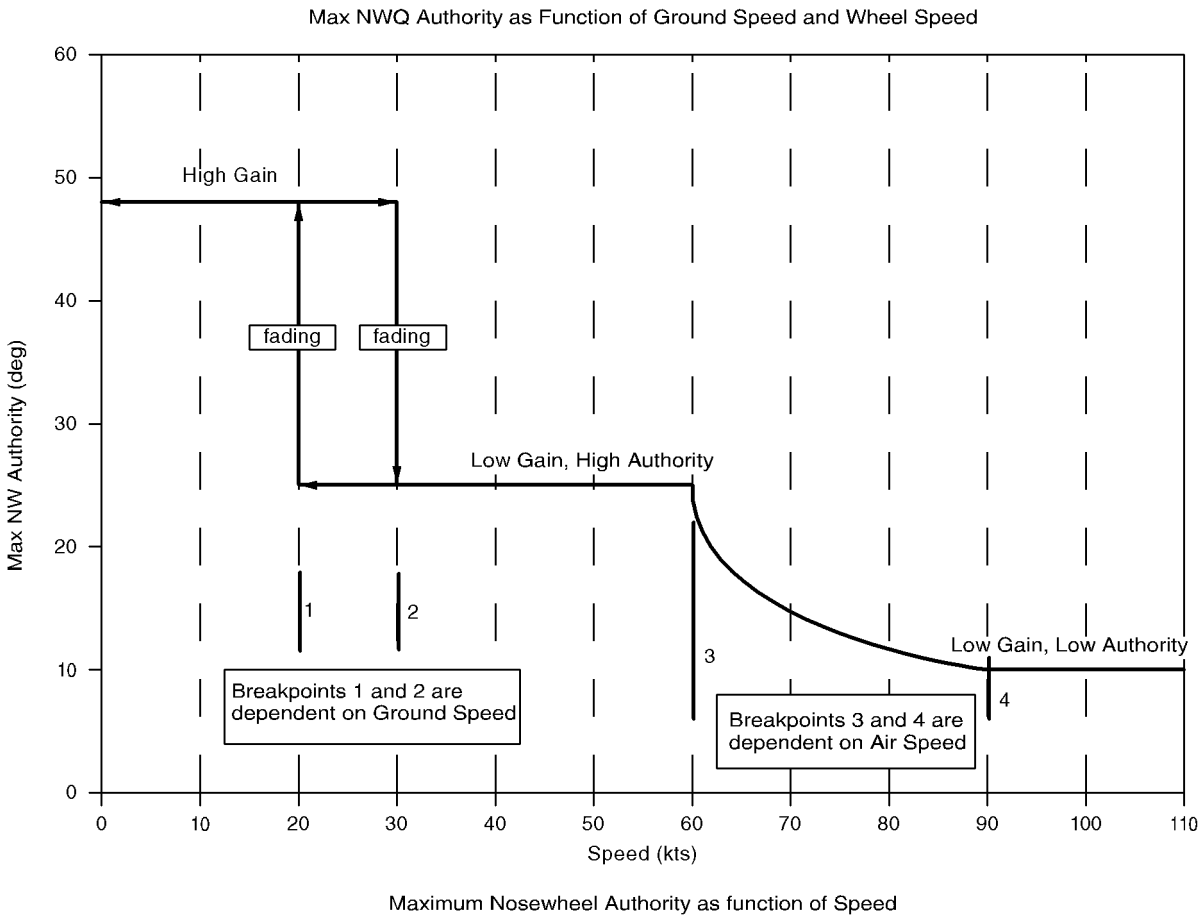
NWS Concept

The FCS controls the NWS by determination of the NWS state. This process distinguishes between:

– Pre-Take-Off/Landing
– Airborne/Approach, and
– Free Caster State.

Nosewheel Authority Scheduling

The nosewheel is scheduled as a function of airspeed with deflection decreasing with increasing speed. When no failure exists, the nosewheel authority blend from low speed (+/- 43°) to a mid-speed schedule (+/- 28°) between 20 to 30 kts GS, and the blend to the high speed schedule (+/- 10°) occurs between 60 to 90 kts airspeed. The changeover out of the low-speed is also dependent on throttle position, i.e. advancing both throttles out of the idle to a close to Max Dry position will result in an instantaneous switch-over to mid speed mode. (Figure 1.123.)



Maximum Nosewheel Authority as function of Speed

Figure 1.123 - Nosewheel Authority Schedule

Pre-Take-Off/Landing

The NWS is engaged by the TOT/NWS/RESET indicator push button. NWS may be disengaged via the ICO switch. When engaged, the NWS legend on the TOT/NWS button is flashing low. Manual NWS disconnect via the ICO will cause the NWS legend to flash high and the DWP warning caption to be triggered.

If the system is serviceable but disengaged, pressing the TOT/NWS button will reengage the NWS, with the NWS legend on the TOT/NWS button flashing low again. The DWP warning caption will occult.

To avoid abrupt NWS inputs during the blend from the low speed to the medium speed setting when both throttles are advanced for takeoff, a hysteresis has been added to prevent oscillations if the throttle is set to the break point where the moding takes place. The changeover during deceleration from high speed (+/-10°) to medium speed (+/-28°) is accomplished when at least one throttle lever position is reduced below the break point of the moding (~ 60 kts).

Airborne/Approach

Once weight is off the wheels sensed, i.e. when airborne, the NWS is disengaged . When the landing gear is selected down, ICO will not disengage the NWS in the air. The NWS can be re-engaged by pressing the TOT/NWS push button, allowing automatic engagement on ground.

Free Caster Mode

In the case of a confirmed NWS failure the NWS will enter the free caster mode, whereby directional control may only be accomplished through the use of differential brake pedal inputs.

NWS Indications

FCS RSET

NWS engagement is indicated by:

- Occulting of the DWP NWS warning caption
- Slow flashing of the NWS legend on the TOT/NWS push-button (in high gain mode only)
- Occulting of the NWS indicator on the ACUE format.

NWS disengagement is indicated by:

- Display of the NWS DWP warning caption.
- Fast flashing of the NWS legend on the TOT/NWS push-button (if NWS is possible to engage via TOT reset)
- Extinguishing the NWS legend on the TOT/NWS push-button (if NWS is not possible to engage due to NWS position range exceeding)
- Setting the NWS indicator on the ACUE format.

DWP

In the case of a NWS failure condition, a CAT 2 NWS or CAT 3 NWS (NAV POF only), DWP warning is triggered. ICO will also trigger the NWS warning caption.

Airbrake

(1B-B-27-60-00-00A-043A-A Issue 006)

General

The airbrake is installed on the upper surface of the fuselage just behind the cockpit. It is electrically controlled and hydraulically operated by the right utilities hydraulic system.

Airbrake actuation is controlled by FCC 4 and monitored by FCC 2.

Control Laws

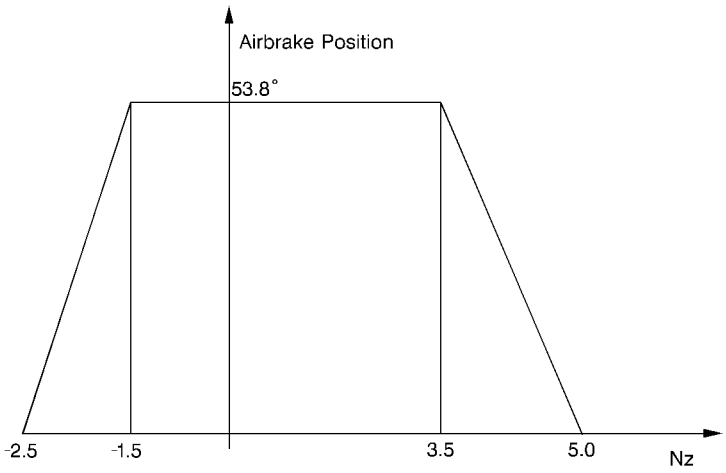
Inputs into the airbrake position schedule are air data, angle-of-attack, measured, predicted and derived load factor and the airbrake activation signal.

For the LDG DOWN AOA is the only input to the authority schedule. With the LDG in the DOWN position the airbrake is allowed to stay out to a higher command compared to normal low speed flight with LDG UP.

Output is the demanded, amplitude and rate-limited airbrake position signal to the actuator. A further element affected is present in the rudder/pedal path. In this path the demanded sideslip is calculated and the max sideslip authorities are scheduled with the airbrake selected in or out.

Airbrake Position Schedule

The aerodynamic airbrake position limit is scheduled as shown in Figure 1.124. An hysteresis and rate limit is applied to AOA to prevent cycling of the airbrake. The authority is cut down immediately with increasing alpha. There is a difference in the schedule for high and low Mach number. One authority signal is based on angle-of-attack and Mach number. A second authority signal is calculated from the max and min load factor (Nz).



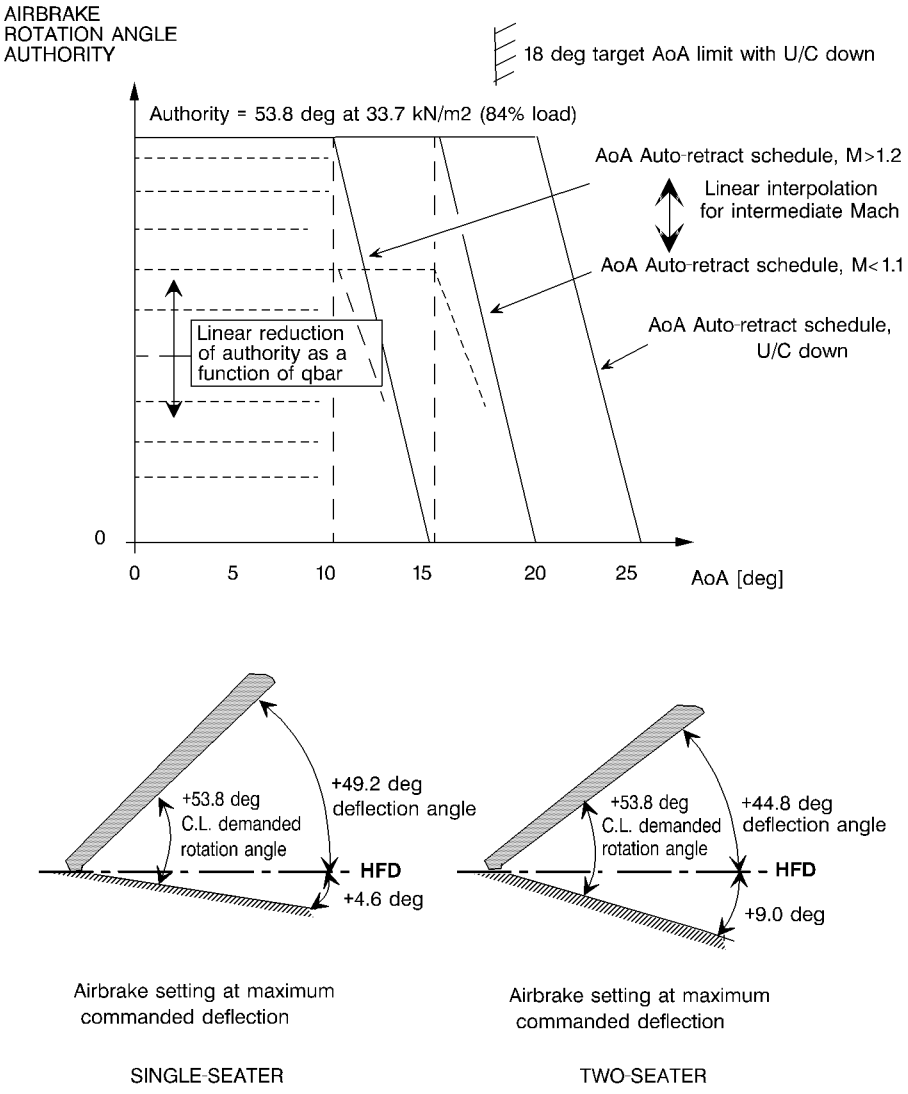


Figure 1.124 - Airbrake Schedule

The scheduling provides protection for speeds or load factors in excess of the A/B out schedule, but it also automatically retracts the airbrake if the nominal flight envelope limits are exceeded.
There are only two positions to be commanded: Fully in and fully out. The airbrake activation signal commanded by the pilot will result in either extend the airbrake, in accordance with the control law schedule, or to fully retract it. Note that the cockpit button is a spring-loaded switch. If the button is released the switch jumps back to default. In default the signal is ZERO and therefore holds the previously demanded airbrake position (fully in or fully out). No intermediate airbrake position is desired in the nominal mode.
If the A/C passes through the scheduling limits with airbrake out and the maximum position is therefore automatically changed or the airbrake is even fully retracted, then the previously commanded airbrake status (Airbrake out) is stored and automatically restored if the flight condition allows for it.

Controls and Indicators

Airbrake Switch

The airbrake is controlled via a three position sprung to center selector mounted on the throttle top.

HUD

When selected to out, the airbrake position is indicated in the HUD by a green symbol above the aircraft symbol. It is steady when airbrake is deployed and will occult when the airbrake is fully retracted in.

DWP

A BRAKE

Trim System

(1B-B-27-05-00-00A-043A-A Issue 007)

General Functionality

In pitch and roll the aircraft is trimmed automatically from within the control laws for most of the flight envelope. A parallel manual trim function is also provided via the stick top trim switch whenever this function is enabled by setting the DATUM ADJUST/ TRIM switch to the TRIM position and having the AP disengaged.
In the yaw axis, manual trimming only of the rudder is available via a switch mounted on the left console.
Manual trim authorities are speed scheduled. Trim inputs are not additive to normal stick and pedal control authorities limits. Thus, use of the trims cannot be used to augment the stick and pedal control power.

NOTE

- AT FCS FPSP1A AND 1A+ THE AP FUNCTION IS NOT AVAILABLE, HENCE THE DATUM ADJUST/ TRIM SWITCH SHOULD BE TRIM (AFT).
- SIMILARLY, THE TRIM BUTTON ON THE STICK IS CONFIGURED TO ACCEPT MANUAL TRIM INPUTS ONLY.

Use on the Ground

Following engagement of the FCS, manual trimming in all three axis is available provided the throttles are at idle. Moving any trims away from neutral will cause the TOT indicator in the FCS RSET push-button to flash at a slow rate. Pressing the FCS RSET button will reset all trims to neutral and cause the TOT legend to become steady (checking of the manual trim function during start up is not essential for flight safety). If either throttle is moved above idle, manual trimming is disabled and all trims are set to the takeoff position (neutral) and maintained there until weight comes off the nose wheel during takeoff.

Use in Flight

Pitch Axis

There is no requirement to trim the aircraft in pitch throughout a vast proportion of the speed range. The aircraft self-trims to zero pitch rate at center stick throughout the speed envelope below 17° AOA. Above 17° AOA, nose down static stability is progressively introduce via AOA feedback. Manual pitch trim is active only below speeds of 186 KDAS and can be used to cancel the static stability effect for AOAs up to the value corresponding to 25% aft stick. At slow speed therefore an aft stick input is required to maintain high (> 20°) alpha and this understandable cannot be trimmed out. At slower speeds the pitch control law is an alpha demand and increasing amount of aft stick is required to maintain zero pitch rate with full back stick being required at limiting AOA. This understandable cannot be trimmed out. Manual trim inputs are automatically cancelled when the speed increases above 186 KDAS.

Roll Axis

In the roll axis, the aircraft is self-trimming via an Auto Roll Trim (ART) function at all speeds down to

150 KDAS below which the ART function is disabled. The ART is active in the maneuver envelope +/- 60° pitch/bank between + 15° and - 5° AOA whenever the roll stick and rudder pedals are centered. Outside this envelope, the last good auto trim offset value is retained for use in the roll command path. The trim settings applied by the ART are fully compensated for normal g effects. The lateral trim offsets required to balance asymmetric stores are fed directly into the ART system via the control laws using stores data supplied by the ACS.

There are three sub-modes contained within the ART as follows:

– Bank Angle Hold: This operates between 7° and 60° of bank and maintains constant bank angle.
– Wings Leveller Mode: This operates at bank angles of less than 7° and will cause the aircraft to roll very gently towards 0° bank angle.
– Fly Straight Mode: This mode works as a pseudo-heading hold mode. It will cause the aircraft to fly in a straight line by applying a small amount of bank to offset lateral CG asymmetries provided the aircraft is trimmed out directional. Directional mis-trimming will cause the aircraft to fly excessively wing down.

Manual roll trimming is available throughout the flight envelope and may be used to assist the ART particularly in emergency situations involving extreme lateral cg positions or flight with an engine shut down. The manual roll trim system is limited in authority to 40% of full roll stick. Any out of trim manual roll trim inputs will be washed out by the ART system.

Yaw Trim

The yaw trim system has a manual mode only. It operates directly on the rudder angle command path. The authority is set to nominal 70 % of pedal authority. The yaw trim authority is faded to zero between 1.7 M and 1.8 M in order to prevent interference with the primary control laws directional stability augmentation.

Flight Control System Computer Functions

(1B-B-27-01-05-00A-043A-A Issue 003)

General

The high integrity fly-by-wire Flight Control System (FCS) is implemented and integrated around a set of four identical and interchangeable, digital Flight Control Computers (FCCs). Each FCC controls one lane of the system, thus providing redundancy for all critical functions. Interlane data links between each FCC maintain synchronous operation of the computing in each lane. Each FCC also acts as a remote terminal, where two FCCs interface with the STANAG 3910 avionics system bus (AVS) and the other two with the STANAG 3838 utilities control system bus (UCS).

The four FCC perform the central integration of all flight control primary sensor information from the:

– Inertial Measurement Unit (IMU),
– Pilot`s Stick Sensor & Interface Assembly (SSICA) and
– Air Data Transducer Units (ADT).

Each FCC performs the computations to provide data to the AVS and UCS. The primary flight control actuators (foreplanes, flaperons, rudder and leading edge system) and secondary flight control actuators (airbrake, nosewheel steering and air intake cowls) are controlled by the FCC electronics and driven by the output commands of the control law computing in each FCC. Each FCC contains six 32–bit microprocessors (68020) and four coprocessors (68882).

Engine throttle commands are transmitted to the Digital Engine Control Unit (DECU) via the interlane STANAG 3838 FCS system bus.

FCC Modules

The FCC consist of several modules:

– Power supply.
– Lightning and EMC protection.
– EMC filter card for input/output signals.
– Communications card for STANAG 3838 and 3910 bus terminal control.
– Analogue input card for processing signals.
– Processor & Data Management card for interlane data links and processing for input/ output signals and actuator drives.
– Two analog output cards for actuator valve current drives and processing for control laws and air data.
– Fibre optic module for STANAG 3910 optical/ electrical interfaces.

Power Supply

Each FCC power supply unit has two separate 28V bus bar inputs, one being battery backed up. It provides internal supplies for the analogue and digital computing and the 45V supply for the primary actuator direct drive valve current amplifiers. The power supply also provides own lane power to one ADT and the SSICA (both for TWS). The power supply includes a short duration hold up facility to compensate for bus bar voltage drop down.

Flight Control System Built In Test

(1B-B-27-00-00-00A-343A-A Issue 007)

General

The Flight Control System (FCS) incorporates extensive Built In Test (BIT) facilities to accomplish failure detection and failure isolation. The BIT thus indicates functional equipment performance or failure modes to determine the operational readiness and to evaluate the status of the FCS.
The FCS BIT functions are part of the aircraft Integrated Test System (ITS). The FCS BIT includes:

– Initiated Built-In-Test (IBIT), and
– Continuous Built-In-Test (CBIT).

Bit Operational Modes

The FCS BIT comprises two modes, namely the Initiated BIT (IBIT) to detect failures on ground and during preflight check and the Continuous BIT (CBIT) for in flight assessment.
In the TWS aircraft all IBIT moding pilot interactions can only be performed from the front cockpit (FCS TEST/BIT button only in front cockpit). The progress and results of the IBIT functions are displayed as status indications on the ACUE format and by the TOT/NWS/RESET button.

Initiated Bit (IBIT)

The on ground FCS checks are performed by the IBIT function to enable the pilot to assess autonomously the operational level of the FCS before takeoff down to module level. Adequate interlocks are provided to ensure IBIT operation on ground only.
The IBIT is divided into three operational levels:

– Pre-Flight Check (PFC)
– Actuator Movement Check (AMC)
– First Line Check (FLC).

Pre-Flight Check (PFC)

The PFC includes:

– Automatic PFC on all FCCs
– Determines the status of the overall FCS by checking the IBIT status of other FCS LRIs
– Performs full FCS configuration check
– Checks IMU harmonization data and course alignment status
– Records all FITs
– Generates a maintenance message for each FIT bit
– Generates PFC status indications on the ACUE format and other cockpit indicators, e.g. TOT button.

The PFC will run automatically when the a/c is powered up (BATT on), or can be re-run by the pilot (Repeat PFC) provided the engines are not running yet and a previous PFC failure has been detected.

Actuator Movement Check (AMC)

After the successful completion of the PFC, the AMC can be initiated by pressing the FCS TEST button, provided hydraulic power is available. The AMC involves the physical movement of all primary and secondary actuators, except the NWS, and is selectable by the pilot via the FCS TEST button. Selection is only possible after a PFC/R-PFC GO and with both hydraulic systems available. It consists of:

– Actuator movement checks on all primary actuators
– Actuator movement checks on LEAS, AB and L & R COWL
– FIT recording
– Generates maintenance messages.

Entry into AMC is inhibited when the FCS has entered Fight Resident Software (FRS). Status indications are displayed on the ACUE format, on the FCS TEST button and on the FCS RSET button.
If the AMC is interrupted by means of the ICO, the FCS puts the actuators in a safe mode. A repeat AMC following ICO interruption is possible. Following AMC abort the BIT illumination legend flashes and pressing the BIT button will return the system to the IBIT mode select where AMC can be repeated.
If the AMC is terminated due to hydraulic power failure or finished with a GO or NOGO the IBIT mode is automatically entered again, and the FCS readiness to enter FRS will be dependent only from the AMC result.

First Line Check (FLC)

The FLC will perform more comprehensive tests of the FCS LRIs and also provide the facility for Upload Mass Properties (UMP) and ADT/IMU harmonization data upload. The FLC can be initiated after PFC or AMC via dedicated MHDD soft keys or via dedicated ground equipment (ATE).

In Flight Continuous Bit (CBIT)

The CBIT function will be performed automatically and continuously whenever the FCS in flight software is active. FCS related failures will be indicated on the DWP.

FCS Status Indications

The related BIT indications are summarized at Table , “FCS Status,” on page 1-256.

FCS Status

FCS RSET BUTTON	FCS TEST/BIT BUTTON	CONDITION	MHDD/ACUE INDICATION
OFF	BIT lit BARS lit	BATT switch ON	FCS NOT READY; PRE-FLIGHT BIT IN-PROGRESS
OFF	BIT lit BARS flash	PFC FAIL R-PFC selectable	FCS NOGO; PRE-FLIGHT BIT AVAILABLE
OFF	OFF	PFC pass HYD not available	FCS NOT READY
T/O legend flash (Note 1)	BIT lit	PFC and/or AMC pass HYD available	FCS READY; ACTUATOR BIT AVAILABLE
OFF	BIT lit BARS lit	AMC selected via FCS TEST button	FCS NOT READY ACTUATOR BIT IN PROGRESS
OFF	BIT lit	AMC fail AMC re-selectable	FCS NOGO ACTUATOR BIT AVAILABLE
T/O lit NWS flash	OFF	FRS entered via FCS RSET button	EMPTY
T/O lit NWS lit	BIT lit	SEL MODE available from FRS (no motion & no engines running)	PRE-FLIGHT BIT AVAILABLE
OFF	BIT lit BARS LIT	AUTOMATIC R_PFC ON ENTRY IN SEL MODE	FCS not READY; PRE-FLIGHT BIT IN PROGRESS
OFF	BIT lit BARS flash	PFC fail R-PFC selectable	FCS NOGO; PRE-FLIGHT BIT AVAILABLE
OFF	OFF	POWER DOWN	EMPTY

Note 1:

– The readiness of the ACS system does not influence the FCS Normal Mode availability, but the a/c is prohibited to fly without the check passed (FCS MASS warning is triggered on entry into FRS).

– For this Phase FRS can be entered without IMU fine alignment complete (only course alignment complete). The IMU fine alignment uncompleted does not influence the Normal Mode availability but as a consequence the True heading is not available. If the fine alignment is ongoing this is indicated by the fast flashing of the TOT legend. The TOT legend will flash slowly when fine alignment is complete.

For further ACUE format status indications refer to Pre Taxi Checks pag. 2-18.

Flight Control System (TWS)

(1B-B-27-01-19-00B-111A-A Issue 005)

General

NOTE

For arbitration and switch moding refer to Flight Control System (Twin Seat) pag. 1-237.

Control and monitoring of the FCS is achieved by a combination of dedicated controls, switches and displays.

Dedicated Controls, Switches and Indicators

Controls

The controls comprise the pilots stick, rudder pedals, FCS related control switches, push-buttons and indicators.

Control Stick

Identical control sticks are provided in each cockpit which allow the pilot of the cockpit in control full authority in pitch and roll. The pitch stick travel contains an override region whereby the stick may be pulled through an aft detent (20% additional aft) to give additional emergency pitch control authority.

Pitch and Roll Trim Button

The pitch and roll trim button is located on the control stick top. The button is a standard duplex 4 way position toggle button, spring biased to center, which drives integrators in the flight control computers (FCCs). The button is moded according to the DATUM ADJUST/TRIM switch setting. Arbitration between the controls ensure that only the button in the cockpit in control is active.

Instinctive Cut Out Switch (ICO)

The ICO switches are located on the stick tops. Operation of ICO in either cockpit has the following effect:

– ICO from cockpit in control: disconnects the NWS, the Autopilot (AP) and the Autothrottle (AT).
– ICO from the priority cockpit (instructor) if not in control: initiates rapid takeover and disengages AP & AT functions.

Autopilot Engage / Disengage Pushbutton

NOTE

At FPSP1a the AP function is omitted.

The button is located on the left side of either stick.

Throttles

The throttles in both cockpit are identical. A mechanism is provided that allows the front and the rear cockpit throttles to have identical movements. The throttles are used to interface with the DECU (Digital Electronic Control Unit) but also to provide various interfaces with other FCS controlled systems.

Autothrottle Engage / Disengage Push-Button

The button is located on the upper side of the right throttle in either cockpit.

Airbrake Control Switch

An airbrake control switch is available in each cockpit. The switch is a two position spring to center toggle switch located on the right throttle. Momentary actuation of the airbrake switch selects the airbrake to a fully in and locked position (switch forward) or to the out position (switch rearward).

Rudder Pedals

Each cockpit is equipped with rudder pedals, which are mechanically connected. The rudder pedals are used for demand to the rudder via the FCCs, to kick off drift on landing, for demand to the nosewheel steering when the weight on nosewheel signal is present, or for braking purposes. The rudder pedals can be adjusted by a pedal adjust handle.

Landing Gear handle

The landing gear handle is only provided in the front cockpit. LDG status indicators are provided in the front and in the rear cockpit.

Pilot In Command Control (PIC)

The rotary switch (role selector) is only available in the front cockpit.

Pedestal Panel

The Disorientation Recovery Function (DRF) button is covered by a safety guard and not cleared for use at this standard.

Left Console

FCS RSET

CAUTION

IF THE COVER GUARD OF THE FCS TEST BUTTON IS LEFT IN THE OPEN (UP) POSITION, THE FCS RSET BUTTON FUNCTION IS DISABLED.

The push-button is available in both cockpits. The FCS RSET control selector/indicator is a momentary push button that enable a number of FCS functions to be performed. The quadruplex button is labelled FCS RSET (panel marking) and NWS-T/O (split indicator). The split legends NWS and/or T/O illuminate by integral sources as appropriate.

Configuration Control Override Selector

The CONFIG OVRD push-button is only available in the front cockpit. A dedicated indicator is provided in the rear cockpit.

NOTE

Selection of store group B or C has no effect in FPSP1A.

Moding selections of the CONFIG OVRD are as follows:

– With the coverguard closed any selection of store group is inhibited.
– With the coverguard open, manual selection of any store group (A, B or C) is possible.
– With the coverguard closed again the last selected configuration will permanently be used and this will be permanently indicated by illuminating the relevant store group.

If a new group is selected this is immediately indicated by the illumination of the relevant group. The selection is also immediately available within the control laws.

Yaw Trim Switch

Each cockpit is equipped with a quadruplex yaw trim switch. Toggling the trim switch to the left or right increments manual yaw trim via an integrator.

FCS Test Push-Button / Indicator

CAUTION

- THE FCS TEST COVERGUARD MUST NOT BE OPENED UNLESS:

  – THE AMC IS INITIATED
  – A REPEAT PFC IS INITIATED.

The control is only available in the front cockpit. A quadruplex coverguarded test push-button providing an integral amber BIT and associated bars (box) illumination. After power switch on the FCS automatically initiates the power up BIT (PBIT) which lasts appr. 60 seconds, during which the BIT legend and the bars on the FCS TEST button are lit.

Intake Emergency Control Switch

Each cockpit is equipped with the coverguarded, two position (AUTO/OPEN), spring biased to AUTO switch. Manual selection to the OPEN position allows the respective or both cowl surface(s) to move downwards (OPEN) as long as the switch is held to the OPEN position. In the absence of a detected failure the switch has no overriding function.

DATUM ADJUST/TRIM Switch

NOTE

At FPSP1a and 1a+ the AP is not available. Hence, the switch shall be set to TRIM (aft).

Each cockpit is equipped with the two position, bi-stable toggle switch. DA is the normal position (forward) , whereas TRIM (aft) is used occasionally when manual trims in pitch and roll are required.

Summary of FCS dedicated Cockpit Illuminations

The following FCS related dedicated cockpit illuminations are available in Table on page 1-258.

Illumination		
	FRONT	REAR
FCS TEST - PFC	X	-
FCS TEST - AMC	x	-
FCS RSET NWS & T/O	X	X
CONFIG OVRD A B C	X	X
REV FCS	X	-

X indicates that illumination is active.

Illumination and Arbitration between the Front and Rear Cockpit

The arbitration of the FCS related signals, the different functions and which cockpit the function is available are included in Table on page 1-259.

Function	FRONT	REAR	ARBITRATION
Stick pitch/roll	X	X	Type 1
Pitch/roll trim	X	X	Type 1
Yaw trim	X	X	Type 1
TOT/NWS/FCS RSET	X	X	Type 1 (Note 1)
ICO	X	X	Type 1
Airbrake	X	X	Type 1
Throttle lever position	X	X	Type 1 (Note 2)
AT datum set	X	X	Type 1
AP engage/ disengage	X	X	Type 1
AT engage/ disengage	X	X	Type 1
AP baro ALT select *	X	X	Type 1
AP HDG select *	X	X	Type 1
DATUM ADJUST/ TRIM	X	X	Type 1
Emerg/Sel jettison	X	X	Type 1
IBIT demand (FCS TEST)	X		Type 3
FCS REV select	X		Type 3
ROLE selector	X		Type 3
ICO (Rapid Takeover)	X	X	Type 4 (Note 3)
AT engage/ disengage (temp throttle override)	X	X	Type 4 (Note 4)
FCS CONT	X	X	CPT not in control
Rudder pedals	X	X	Type 2 mechanically linked
CONFID OVRD select	X		Type 5
CONFIG OVRD override	X		Type 5
LDG select	X		Type 5
EMGY LDG switch	X	X	Type 2 (Note 5)

* not implemented at this standard.

Classification of arbitration signals:

Type 1: Control with cockpit in command.
Type 2: Control with both cockpits irrespective of cockpit in control or priority, no arbitration (mechanically linked).
Type 3: Control from the front cockpit only, however, front cockpit must be in control.
Type 4: Control is available from the priority cockpit, when not cockpit in command.
Type 5: Control available from the front cockpit irrespective of cockpit in control or priority, no arbitration.

Note 1: When on the ground and upon successful completion of IBIT, entry into FRS and setting of TOT and NWS engagement is only possible from front cockpit.
Note 2: There is no fade in between front and rear cockpit throttle demands.
Note 3: ICO from cockpit not in command will be ignored.
Note 4: AT engage/disengage requires special logic because of the instructor cockpit temporary throttle override function.
Note 5: Not under FCS control.

Displays

The FCS functions and warnings can be monitored and are displayed on the HUD, MHDDs, the Get-U-Home instruments (GUH) and the DWP.

HUD

FCS derived information, computed in the four FCCs are displayed in the HUD PDU. These include:

– Baro altitude and barometric pressure setting, airspeed i.e. KDAS/M and vertical velocity.
– Airbrake position (green symbol).
– Landing gear state (D, U and/or X).

MHDD

FPSP1a related data are presented on the following MHDD formats:

ACUE Format

The ACUE format provides BIT sequence and FCS ready indications as prompts.

ENG Format

The position of the left and right intake cowl (INT) is indicated in case of system failures.

DWP

Warning captions associated with the FCS are displayed on the DWP. Refer to FCS/Airdata Failures pag. 3-33, Slats Failure pag. 3-38, Air Intake Cowl Failure pag. 3-39, Probe Heater Failure

pag. 3-39, Airbrake Failure pag. 3-39,Baro Set Failure pag. 3-39, Datum Adjust/Trim Failure pag. 3-40, Low Speed Recovery pag. 3-41.

AUTOPILOT AND AUTOTHROTTLE SYSTEM

Autothrottle (AT) at FPSP1a

(1B-B-27-00-22-01A-043A-A Issue 007)

Autothrottle Functions

The FCS FPSP1a and FPSP1a+ Control Laws (CL) provide the following AT functions:

– Mach Acquire and Hold
– DAS Acquire and Hold.

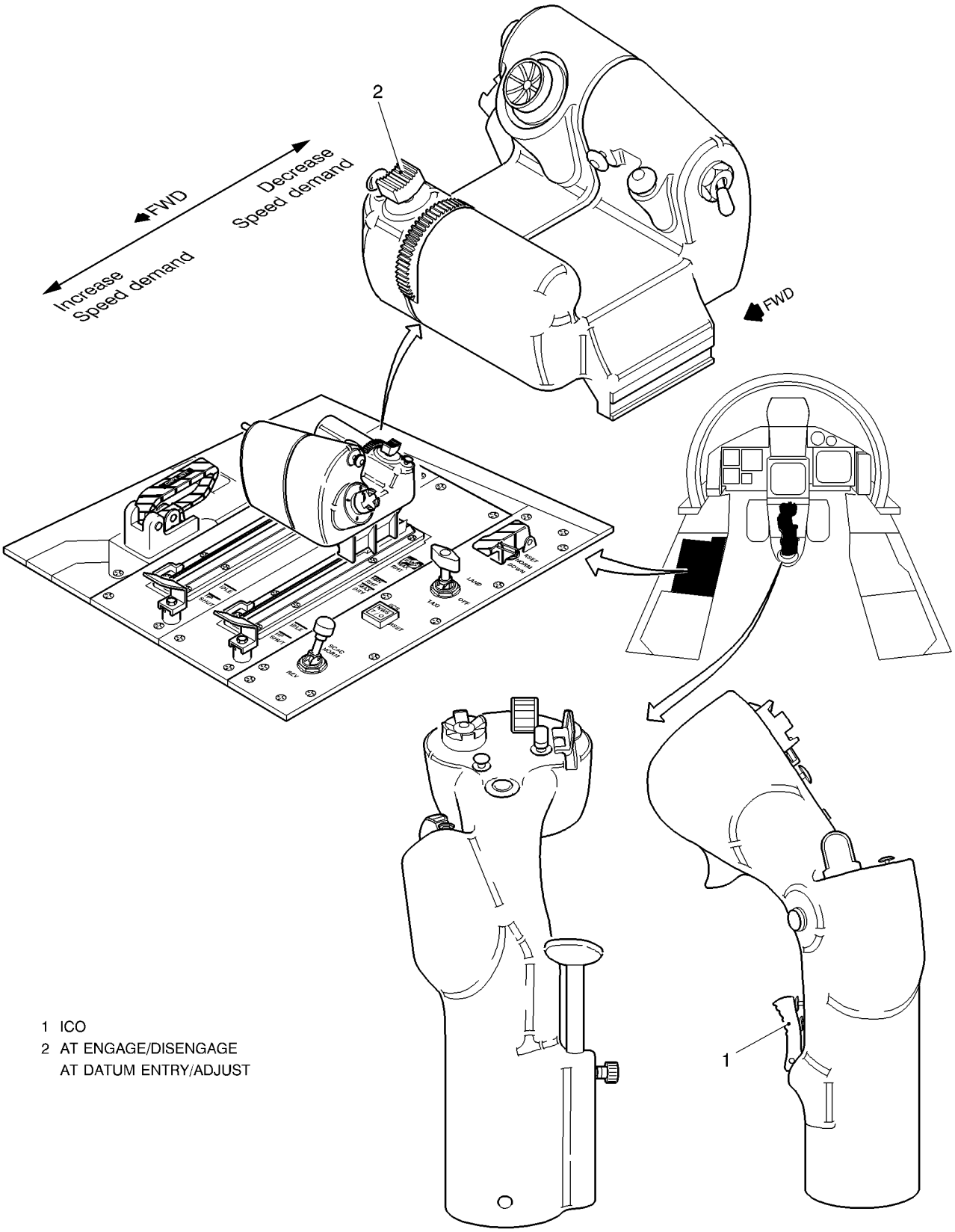
In both modes, the AT either holds the current speed value (in Mach or DAS) or acquires and then holds a pilot-inserted speed datum.
With weight-on-wheels the AT is disengaged and the speed acquisition datum deleted if previously indicated although Mach/DAS selection is retained.

Autothrottle Operation

Engagement Criteria

The AT can be engaged in any flight condition by a short press (< 1 second) on the AT engage button (Figure 1.125). Engagement is not possible with:

– Aircraft weight on wheels
– Throttle lever asymmetry of more than 15mm.



1 ICO
2 AT ENGAGE/DISENGAGE
AT DATUM ENTRY/ADJUST

Figure 1.125 - Autothrottle Engage/Disengage Button

If no mode is pre-selected on engagement the AT will automatically engage in the following modes:

– Altitude below 10 000 ft: DAS Mode
– Altitude above 10 000 ft: MACH Mode
– AT system failure
– Throttles HP Shut

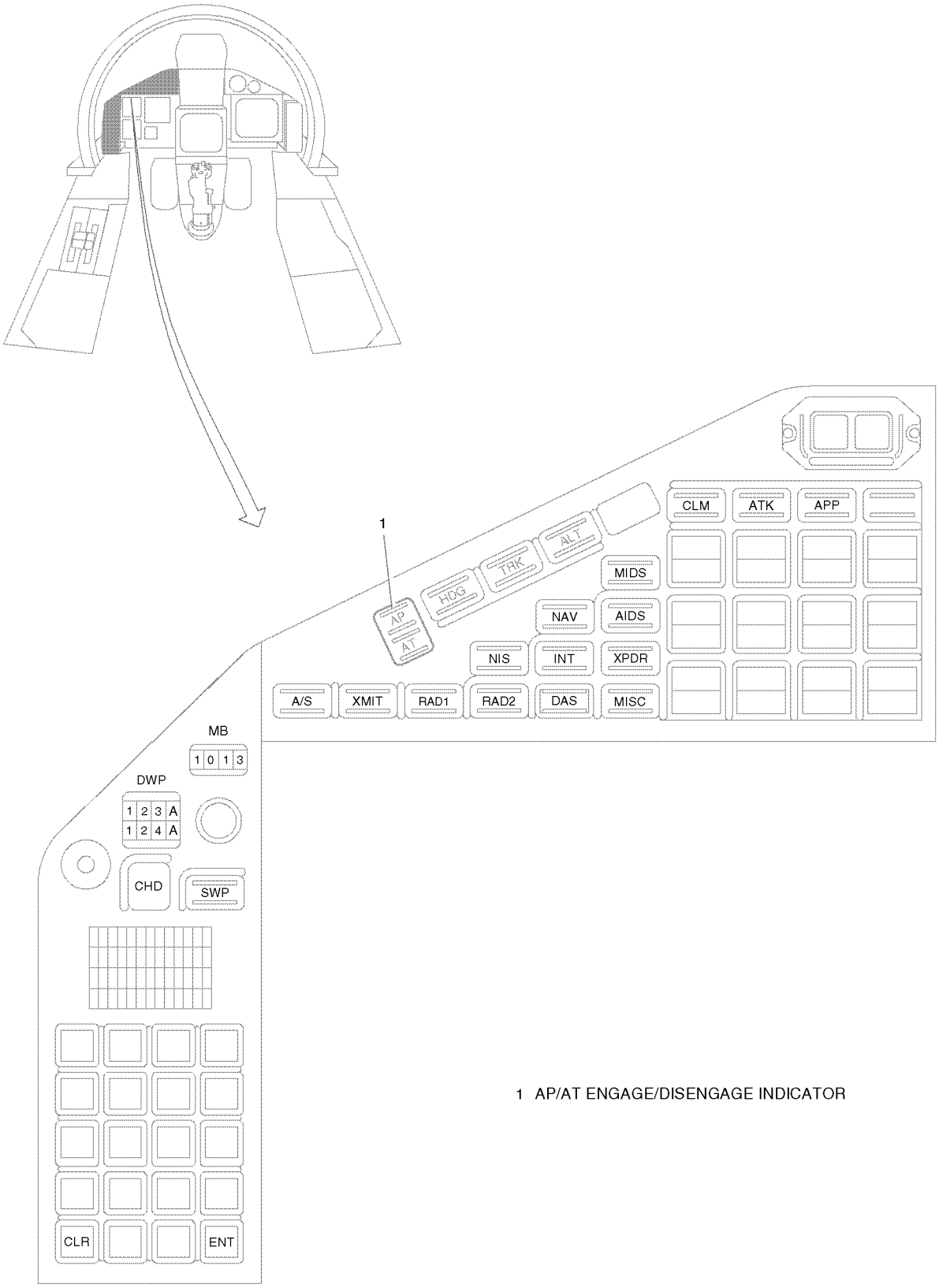
Disengagement Criteria

The AT will disengage if:

– Short press (< 1 second) on the AT engage button
– Throttle override more than 15mm
– Throttle asymmetry more than 15mm
– ICO
– Aircraft weight on wheels
– AT system failure
– Throttles HP Shut

Indications

Autothrottle engaged is indicated on the Left Hand Glareshield (LHGS), split AP and AT indicator button (Figure 1.126). When the AT is disengaged the indicator illumination is occulted.



1 AP/AT ENGAGE/DISENGAGE INDICATOR

Figure 1.126 - Autopilot/Autothrottle Engage/Disengage Indicator

Datum Setting

DAS Datum Input

The AT datum setting button increments or decrements the DAS reference datum between 110 kt and 726 kt using the following law:

– AT button pressed less than 0.4 seconds: increase/decrease by 1 kt
– AT button pressed more than 0.4 seconds: increase/decrease by 10 kt every 0.2 seconds continuous

The DAS datum control law for FPSP1A is:

– <0.4s: increase/decrease 1 kt
– >0.4; <1s s: round to the next multiple of 10 kt
– >1s: increase/decrease 50 kt every 0.5 sec continous.

Mach Datum Input

The AT datum setting increments or decrements the Mach reference datum between 0.18 and 2.0 Mach using the following law:

– AT button pressed less than 0.4 seconds: increase/decrease by 0.01 Mach
– AT button pressed more than 0.4 seconds: increase/decrease by 0.05 Mach every 0.2 seconds continuous

The Mach datum control law for FPSP1A is:

– <0.4s: increase/decrease 0.01 Mach
– >0.4; <1s s: round to the next multiple of 0.05 Mach
– >1s: increase/decrease 0.1 Mach every 0.5 sec continous.

If no datum is set and no mode is selected, AT will automatically select:

– DAS mode if altitude is below 10 000 ft
– MACH mode if altitude is above 10 000 ft

With the datum value starting from the current MACH/DAS.
If a datum is already entered, subsequent DA inputs will adjust the value.

Datum Cancellation

The datum is deleted if:

– AT is disengaged
– No engagement within 120 seconds after datum set (time-out inhibited with weight on wheels)
– ICO.

Indications

MACH or DAS datum is displayed in the HUD.

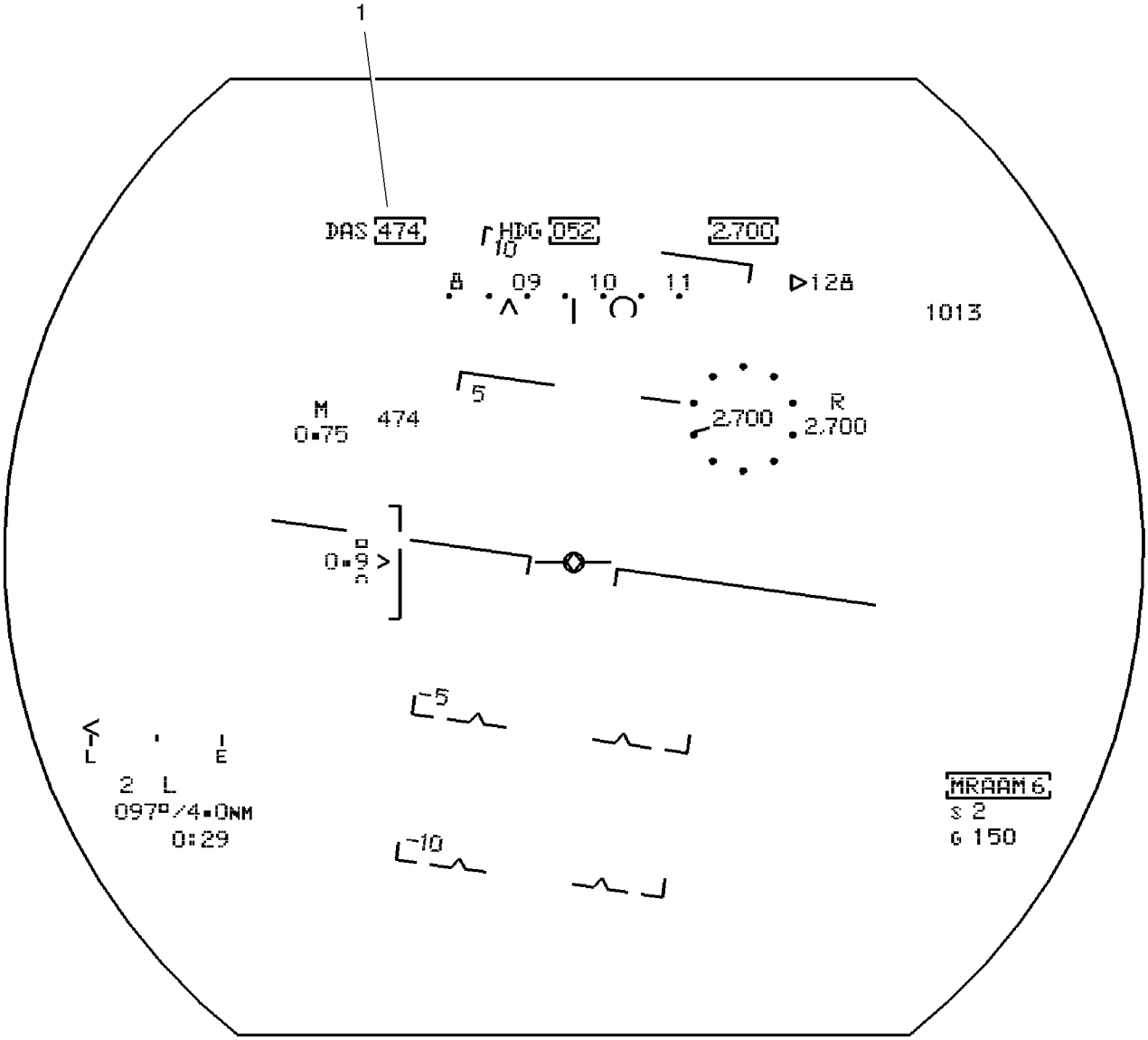
Modes of Operation

AT Hold and acquire Modes

Whenever the AT is engaged, it will acquire and hold the current airspeed or the pre-set datum. AT will indicate hold as soon as the current speed is within 5 kt/0.01 Mach or 2% of the datum, whichever is smaller . If any disturbance (maneuvering or wind) increases the speed error above this threshold the AT will indicate acquisition again.

HUD Indications

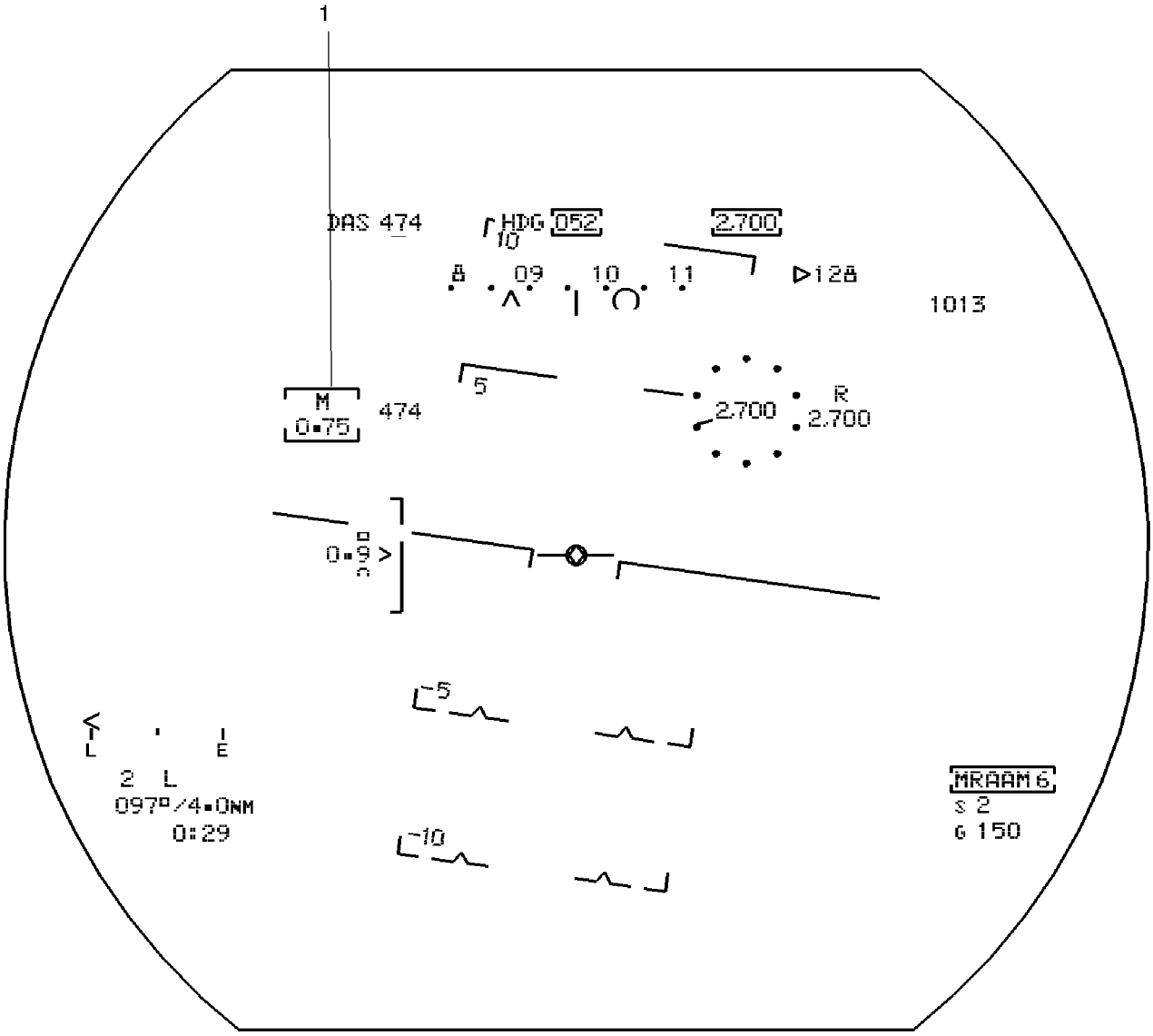
AT Acquire: Mach or DAS datum boxed (Figure 1.127)
AT Hold: Current Mach or DAS value boxed (Figure 1.128).



AT ACQUIRE MODE:

1 AT DAS (or Mach) Acquisition Datum Speed

Figure 1.127 - HUD-DAS Datum Indication



AT HOLD MODE:

1 AT DAS Held Indication
- DAS, when IAS selected (LGS)
- MACH, when M selected (LGS)

Figure 1.128 - HUD-MACH Datum Indication

Selection of Reheat

The AT has no authority to select reheat automatically. In case reheat is necessary, the reheat request voice warning will be triggered and allows to manually select reheat without disengaging the AT. Reheat selection without reheat request warning will result in a manual throttle override (disconnect).

Mode Selection

The AT modes of operation can be toggled by a long press (> 1 sec). When AT is not engaged, the toggle sequence is

– BLANK
– MACH
– DAS
– BLANK.....

and a datum will be deleted.

When AT is engaged there is no BLANK mode anymore, therefore the toggle sequence is

– MACH
– DAS
– MACH....

and a datum will be converted to the respective unit (DAS or Mach) using the current Mach/DAS ratio.

NOTE

In FPSP1a the datum will be deleted when the mode is toggled.

Autothrottle Warnings

There are three warnings associated to the AT:

Voice Warning	DWP Warning	System Action
Select Reheat (CAT 4)	None	if no response within 15 seconds, the warning will repeat every 15 seconds while still required
Autothrottle (CAT 4)	None	AT is disengaged
Autothrottle Fail	**A/THROT**	Autothrottle disconnect

AutoThrottle Twin Seat

All AT relevant controls are duplicated in the rear cockpit and available when a cockpit is “in command”.

The instructor pilot may temporarily take throttle control away from the students cockpit by the following means:

– Press AT engage button and keep it depressed.
– Adjust throttle setting.
– Return throttle control by releasing the AT engage/disengage button.

The AT will be disengaged by this procedure if it was engaged.

NOTE

Failure of the AT button before/during this operation will prevent throttle override/return throttle control from being accessed by the student cockpit.

If the difference between the commanded and the actual throttle position is greater than 36 mm, the AT follow-up function will be cancelled. This mismatch will trigger the <THROT LK> and the <A THROT> DWP warning captions.

An internal failure of the throttle box in either cockpit will fail the AT function and also trigger the <THROT LK> and the <A THROT> DWP warning captions.

NOTE

Once the AT function is cancelled, AT it is lost and cannot be reset, even if throttles are brought back within tolerance.

AIR DATA SYSTEM

Air Data System

(1B-B-27-01-09-00A-043A-A Issue 006)

General

The Air Data System (ADS) forms part of the quadruplex FCS. Its function is to provide airdata of sufficient accuracy and integrity to meet the requirements of the FCS, AVS and UCS.

The ADS comprises four Air Data Transducer (ADTs), an Inertial Measurement Unit (IMU) and the Digital Engine Control Unit (DECU) (Figure 1.129).

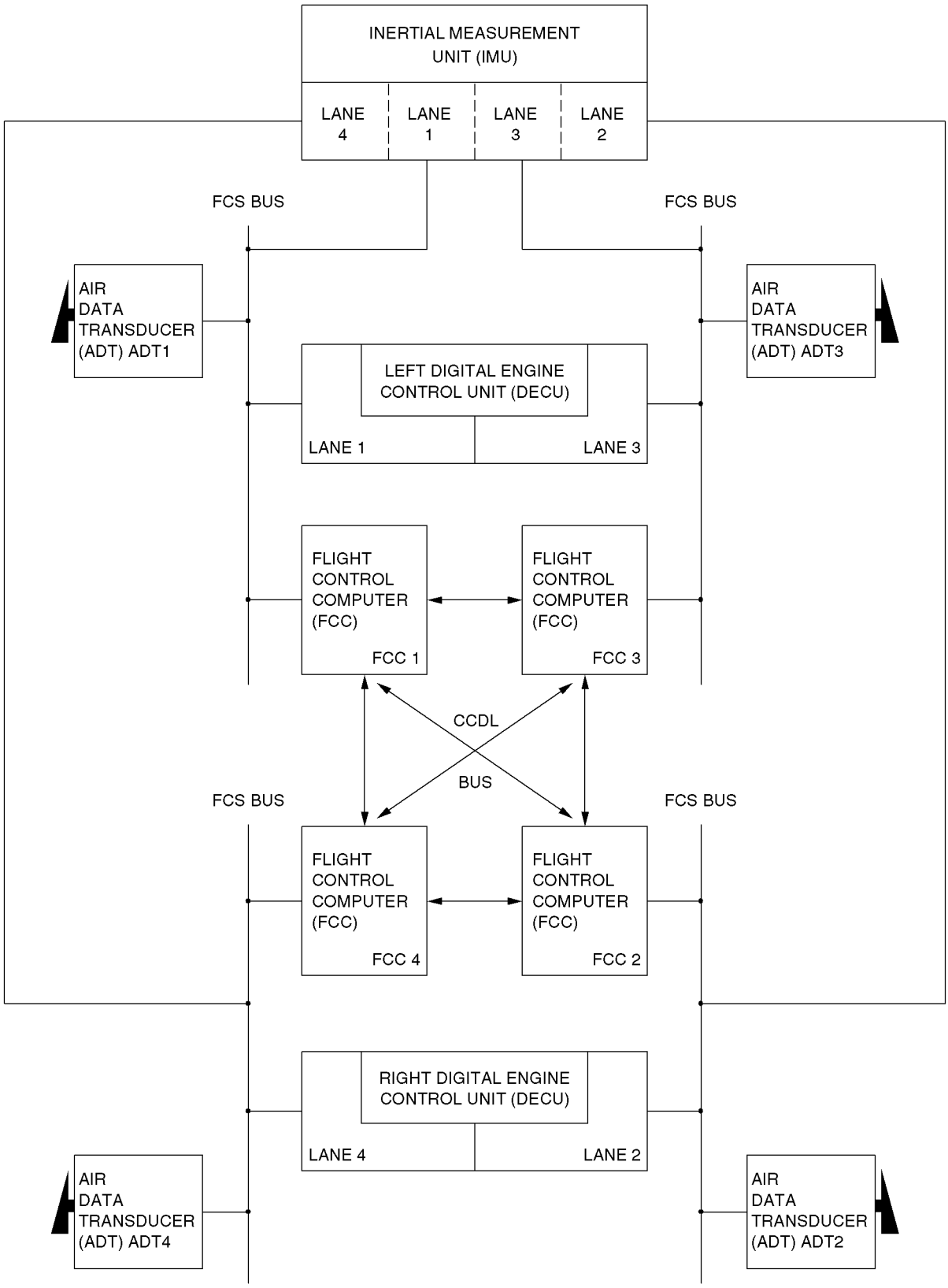


Figure 1.129 - Schematic Diagramm of the ADS System

Air Data Transducers (ADT)

The four ADTs, located on the lower part of the nose cone, are the prime sensors for the independent redundant measurements of static pressure (Ps) and total pressure (Pt), as well as for air data angle of attack (α) and sideslip (β). Transducer errors generated by the disturbance of the airflow because of the presence of the sensors, are corrected within the ADTs.

The four ADTs produce quadruplex Pt and Ps information and triplex α and β information. The two upper probes each provide a α signal and the 3rd is derived from a combined signal from the two lower probes. Similarly, the two lower probes each provide a β signal and the 3rd is derived from a combined signal from the two upper ones. (Figure 1.130)

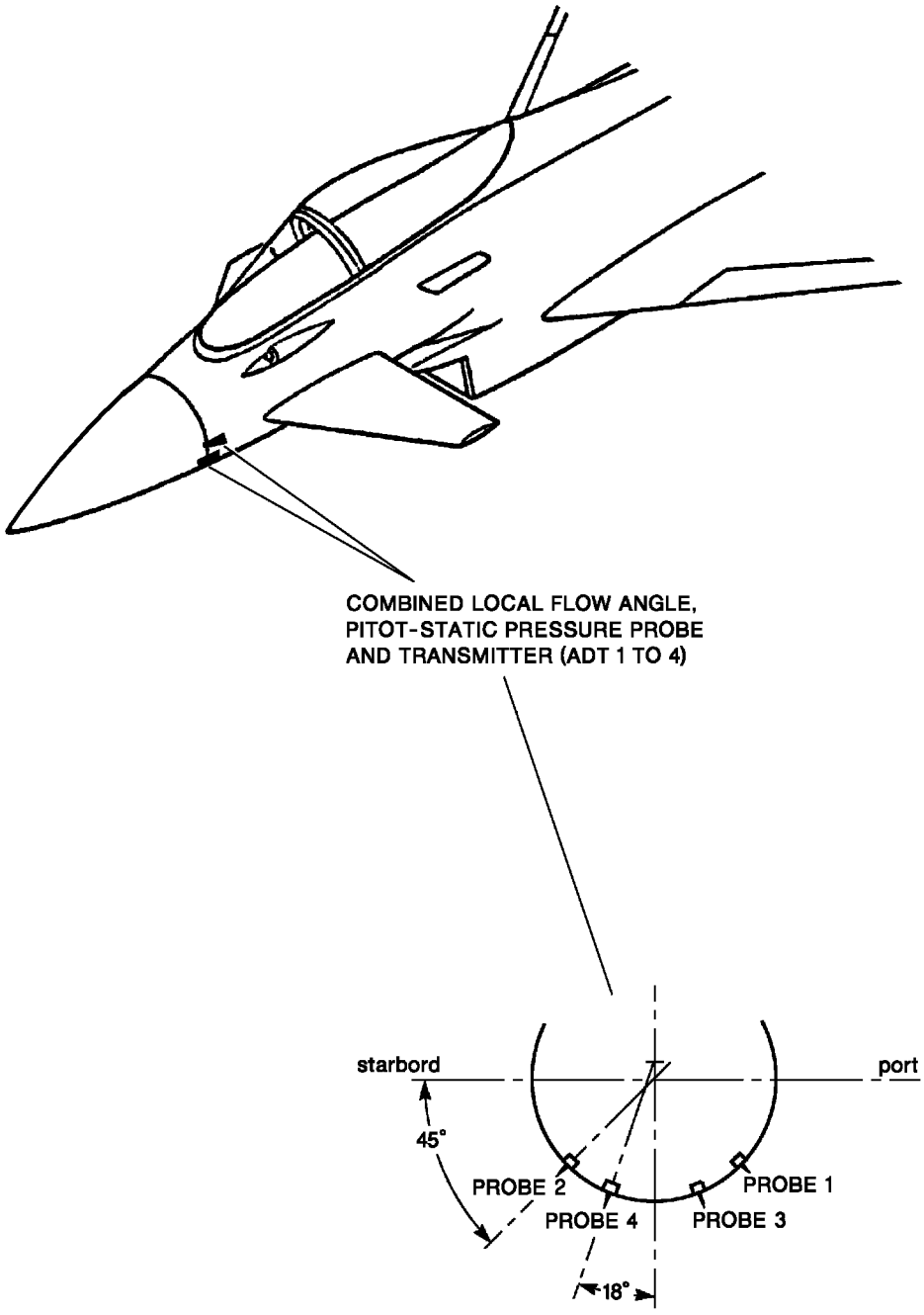


Figure 1.130 - Location of ADT and other ADS Sensors

Inertial Measurement Unit (IMU)

The IMU provides the ADS with inertial angle of attack (α) and inertial sideslip (β). The ADT velocities are mixed with IMU inertial derived velocities to generate mixed α and β within the Air Data Estimator (ADE). The ADS also receives aircraft rate and acceleration data from the IMU and foreplane position from the foreplane position transducer (Figure 1.129).

Digital Engine Control Unit (DECU)

The DECU provides the ADS with quadruplex Mass Flow, Total Temperature (Tt), Ps, and Mach number (Figure 1.129). When performing AAR the ADS uses Ps, Pt from the DECU instead of the pressures from the ADT. The DECU also provides 5th source airdata following failure of ADT derived data.

Summary of Pressure Sources Used

Pressure Sources

	NORMAL MODE	AAR MODE	OUTPUT
ADS PRESSURE SOURCE	ADTs	DECU	DAS, ALT, Mach
ADS AOA & SS SOURCE	ADTs & IMU	ADTs & IMU	Mixed AOA & SS

FAILURE CONDITIONS

For failure conditions and procedures refer to FCS/ Airdata Failures pag. 3-33.

Air Data System

(1B-B-27-01-09-00A-111A-A Issue 004)

General

All data are supplied automatically to the FCS, via the FCCs. The pilot cannot control the ADS, but has some access to choose the type of data being presented.

Dedicated Controls

FCS RSET Control

The FCS RSET control button is used to reset FCS first failures within the ADS. A reset is indicated by the <FCS RSET> request warning.

Barometric Setting

The BARO-SET toggle switch on the LGS allows the pilot to set a required QNH or QFE either by selecting momentary UP or DOWN, or set the switch to the LEFT position when quick standard setting (1013) is required.
For moding of the FCS RSET and the Baro Set control refer to Flight Control System (Twin Seat) pag. 1-237.

Accuracy of Displayed Air Data

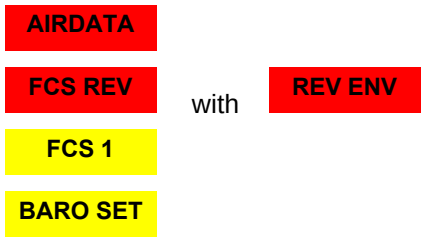
In the event of partial or complete failure of some inputs to the ADS, the accuracy of the FCS based flight data information may be reduced. The relevant parameters that may be affected are:

– AOA
– Airspeed
– Barometric altitude, and
– Mach number

The FCS control laws are designed to account for all possible errors in ADS accuracy while ensuring that aircraft handling remains sound.

Warnings

The following ADS failure warnings may be triggered:



CANOPY

Canopy and Windscreen

(1B-B-56-00-00-00A-043A-A Issue 003)

General

The windscreen is a one-piece acrylic transparency, 22mm thick, attached to an aluminum frame. A demist facility is provided by a gold film heating element, embedded in the acrylic.
The canopy is a one-piece stretched acrylic transparency, mounted in an aluminum frame which is hinged at the rear. The canopy is opened and closed hydraulically and can be operated from inside or outside the cockpit. An antimist system is provided to keep the transparency clear. The canopy is jettisoned automatically on initiation of ejection, and

in the event of an emergency, the canopy can be manually jettisoned .

Canopy Raising and Lowering

(1B-B-56-13-00-00A-043A-A Issue 003)

Introduction

Under normal conditions the canopy may be raised and lowered using the internal or external canopy operating switches. If however, the electrical and hydraulic power fails, the canopy may be opened manually.

Normal Operation

The canopy is opened and closed electro-hydraulically, via the internal or external canopy operating switches. When the canopy is fully closed, two microswitches (mounted on the canopy frame adjacent to the front arch) are tripped and activate the electrical lock/unlock actuator. The actuator drives the canopy locking mechanism (consisting of two shoot bolts and four hooks) via a torque tube and linkage assembly.

The canopy is closed and locked by holding the internal canopy operating switch in the CLOSE position (refer to Canopy and Windscreen pag. 1-272). A warning horn sounds whenever CLOSE is selected and until the canopy is locked. Canopy unlock is indicated on the Dedicated Warnings Panel (DWP) if the throttle levers are >33mm forward and either engine is >40%NH. In addition, CANOPY UNLOCK is also indicated on the autocue.

The canopy is opened and unlocked by selecting the internal or external canopy operating switch momentarily to OPEN. This energizes the electrical actuator fitted to the torque tube, which rotates, releasing the hooks and withdrawing the shootbolts, unlocking the canopy and at the same time deflating the canopy seal. The hydraulic system then raises the canopy until an actuator mounted limit switch (microswitch) is operated (canopy fully open), or a momentary CLOSE selection is made, which will stop the canopy from opening further.

Manual Operation

If the canopy accumulator is fully pressurized, it provides sufficient pressure for a minimum of three open/close operations. If the pressure is insufficient the canopy can be opened manually via the hydraulic system hand pump in conjunction with the internal or external operating switches. This will pressurize the accumulator.

If however, electrical power is not available, operation of either the internal or external switches will fail to open the canopy. Remove the Expandable Diameter Fastener (EDF) on raise/lower torque tube before operating external canopy unlock handle, enabling the canopy to be raised. (refer to Canopy and Windscreen pag. 1-272).

Canopy and Windscreen

(1B-B-56-00-00-00A-111A-A Issue 004)

Internal Canopy OPEN/CLOSE Switch

The internal canopy OPEN/CLOSE switch (Figure 1.131) is a three-position toggle switch, located above the right console, under the sill, in the front cockpit. In the rear cockpit (Figure 1.132) the switch is located on the right quarter panel. The switch is labeled CANOPY - OPEN/CLOSE in the front cockpit and CNPY - OPEN/CLOSE in the rear. It is biased to the center, which is the null position. It controls the raise/lower and lock/unlock function of the canopy. When set momentarily to OPEN, the canopy will open fully but can be stopped in any intermediate position by momentarily selecting CLOSE. To close the canopy, the switch is held in the CLOSE position. Canopy closing can be stopped in any intermediate position by releasing the switch or by activating the external open/close switch to the open position. This reduces the risk of injury to aircrew and ground crew. Operation of the internal canopy OPEN/CLOSE switch is inhibited with weight off wheels. A warning horn is activated whenever CLOSE is selected. Canopy closed/open indications are given on the Multifunction Head Down Display (MHDD) Autocue format.

External Canopy OPEN/CLOSE Switch

An external canopy OPEN/CLOSE switch is located behind the canopy switch access panel (marked CANOPY OPEN/CLOSE), at the leading edge of the left wing route. The switch is labeled CLOSE-OPEN and is biased to the center (null) position. When operated, the switch provides a parallel control function to the internal canopy OPEN/CLOSE switch. The external canopy OPEN/CLOSE switch has priority over the cockpit switch.

Refer to Figure 1.133 for location.

Canopy Vent Switch

The internal canopy vent switch is a push button switch located in the front cockpit, below the internal canopy OPEN/CLOSE switch (Figure 1.131). The push button is labeled CANOPY VENT. When selected and held the canopy is driven to 7° open, regardless of its previous position. Operation of the CANOPY VENT switch is inhibited with weight off wheels.

External Canopy Unlock

In an emergency, with no hydraulic or electrical power available, the canopy can be released by the ground crew, if time permits. Removal of the Expandable Diameter Fastener (EDF) on the raise/ lower torque tube (Figure 1.133), and the operation of unlock gearbox, allows the manual raising of the canopy, which enables aircrew egress.

DWP Canopy Unlock Indicator

If the canopy is unlocked the DWP displays the CANOPY caption and the voice message "Canopy not locked" is heard. The DWP warning is inhibited if the throttle levers are both less than 33mm forward and either engine is less than 40% NH.

Tell-tale Indicators

Yellow tell-tale markings, only visible when the canopy is unlocked, are provided on each of the forward shoot bolts. This enables the aircrew to visually check that the canopy is locked, however, yellow marking will still be visible if the canopy is only partially locked or unlocked.

MHDD Autocue Format

Canopy lock/unlock prompts are displayed on the MHDD Autocue format. These are shown in Figure 1.134 .

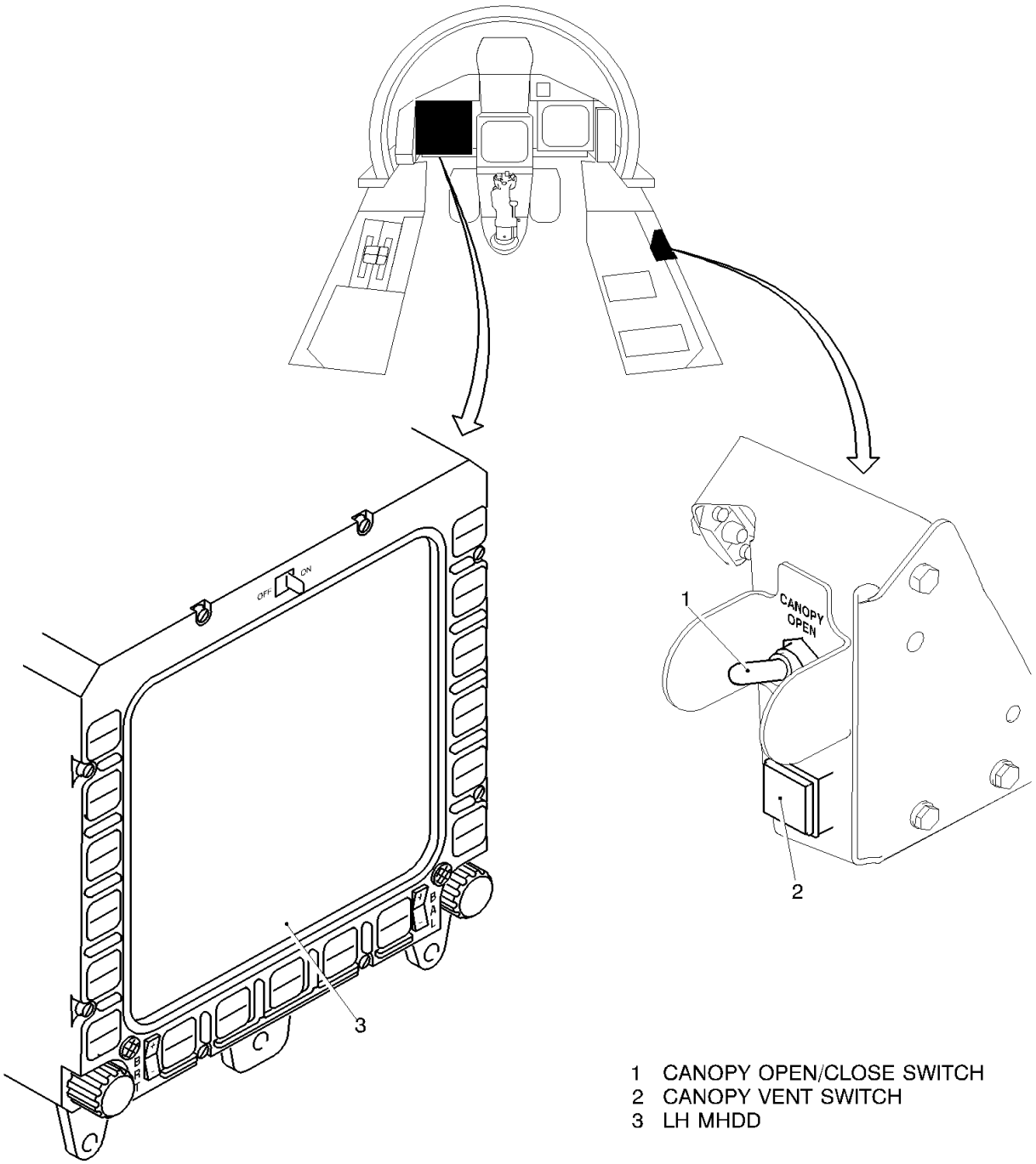


Figure 1.131 - Internal Controls

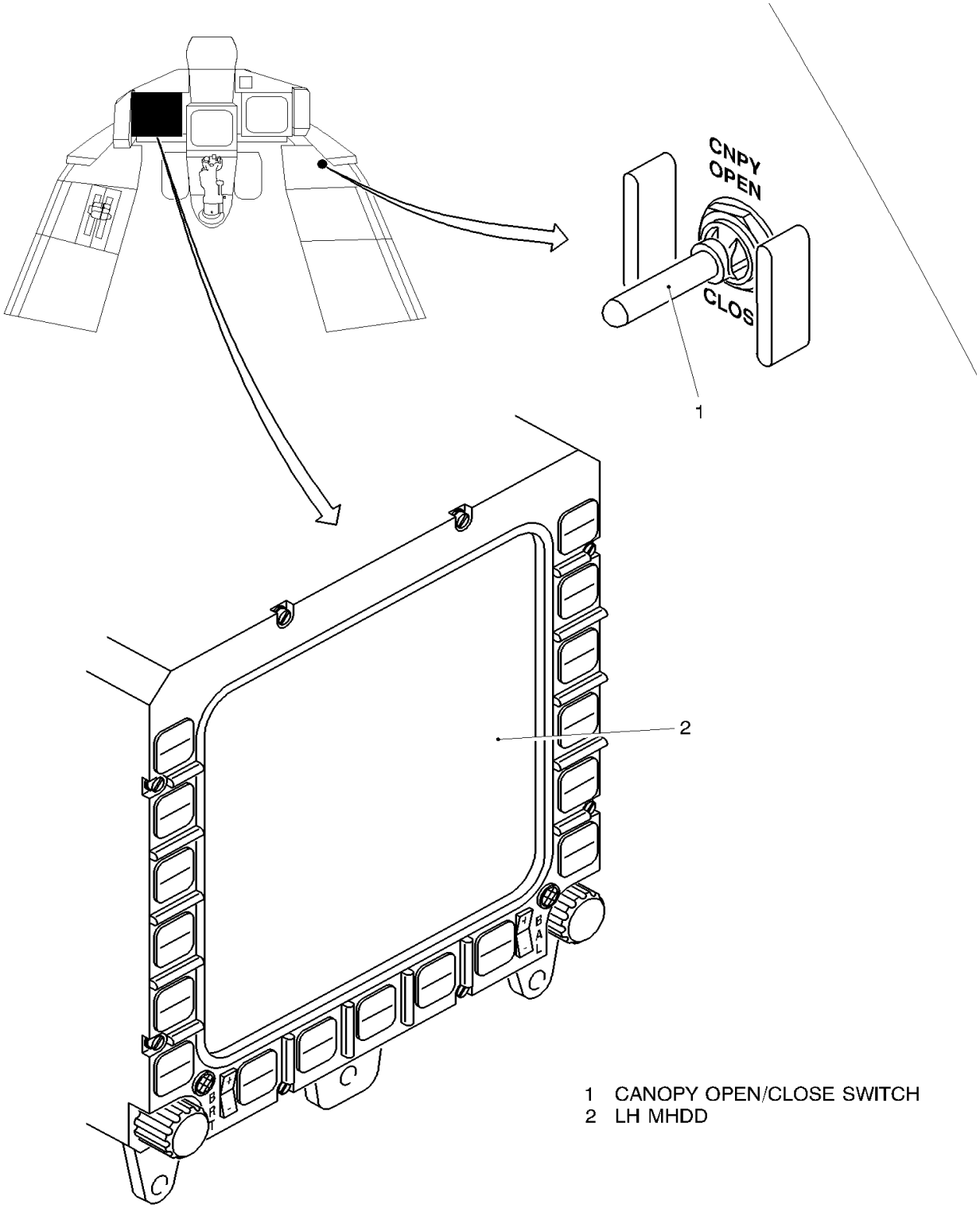


Figure 1.132 - Internal Controls - Rear Cockpit

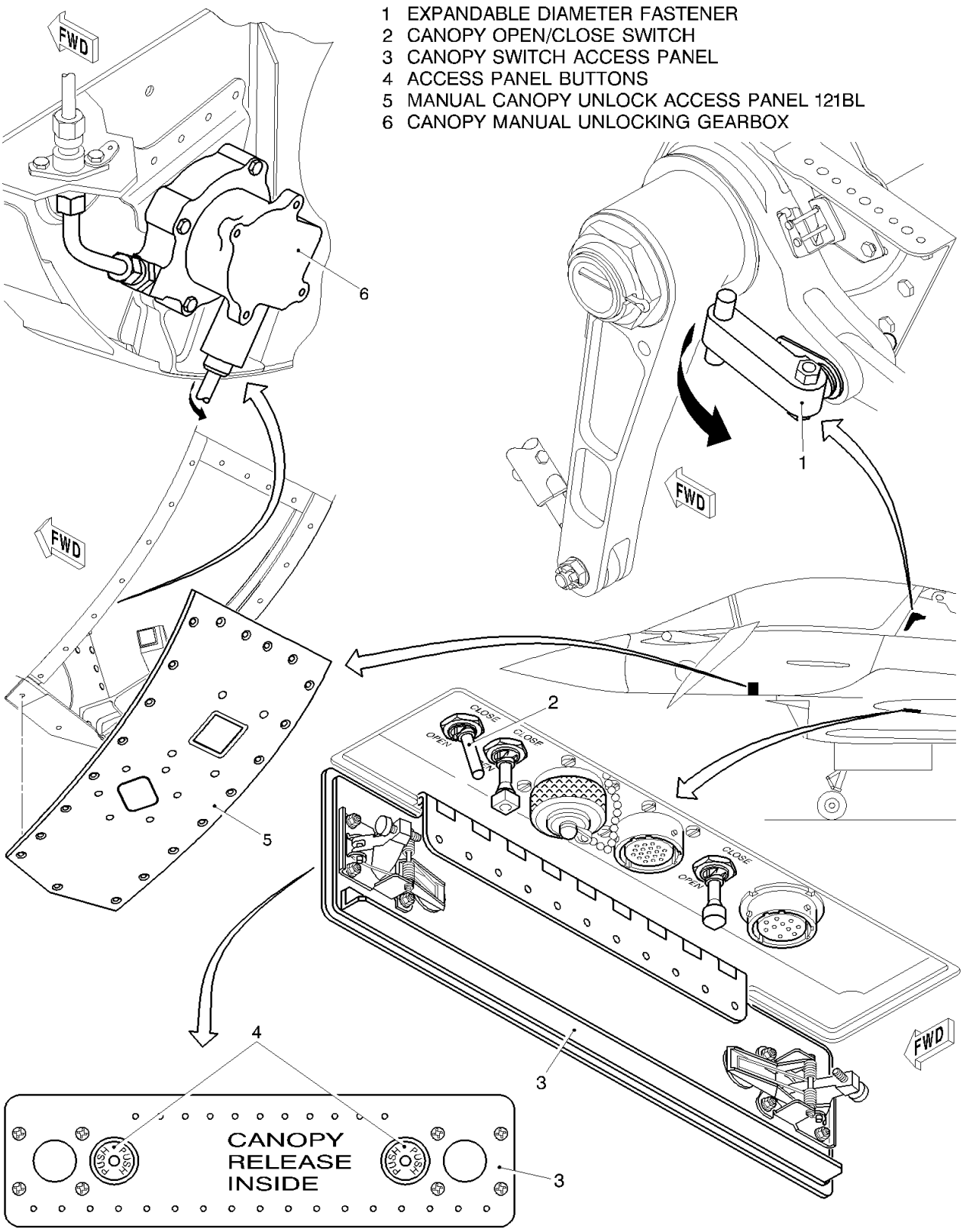
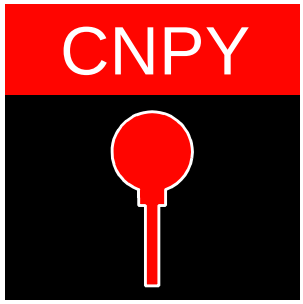


Figure 1.133 - External Controls



CANOPY PIN IN INITIATOR UNIT

CANOPY PIN NOT STOWED

CANOPY NOT CLOSED AND LOCKED

CANOPY NOT CLOSED AND LOCKED
WITH MASS SELECTED TO LIVE

Figure 1.134 - MHDD Autocue Format Prompts

ESCAPE SYSTEM

Escape System

(1B-B-95-00-00-00A-043A-A Issue 004)

Introduction

WARNING

SAFE EJECTION OR CANOPY JETTISON CAN ONLY BE ASSURED IF THE CANOPY IS DOWN AND LOCKED.

The escape system provides a safe means of emergency abandonment (zero altitude to 55 000 ft and 0 to 600 KCAS or Mach 2.0, whichever is lower) and provide for the safe recovery of the aircrew. The ejection sequence begins when the seat firing handle is pulled causing:

1 Retraction of the airbrake (if deployed)

2 Canopy unlock/jettison

3 Seat ejection.

NOTE

The canopy alone may be jettisoned if ejection is not necessary.

For additional information on the ejection sequence, refer to Ejection Sequence pag. 1-286.

If the canopy jettison system fails, the ejection seat will eject through the canopy. For additional information on the ejection seat, refer to Ejection Seat pag. 1-278.

Canopy jettison malfunctions will not interfere with the seat firing. For additional information on the canopy jettison sequence, refer to Canopy Jettison System pag. 1-297.

Ejection Seat

(1B-B-95-10-00-00A-043A-A Issue 005)

WARNING

EJECTION SEATS ARE A POTENTIAL SOURCE OF LETHAL INJURY IF ACCIDENTLY OPERATED.

Introduction

The Mk16A ejection seat (Figure 1.135 and Figure 1.136) is rocket assisted, microprocessor controlled seat which is not dependent on any other aircraft system to fulfil its function.

When the seat is not in use, protection against inadvertent operation is provided by:

1 A seat safety pin inserted into the base of the seat firing handle to prevent it's operation. The seat safety pin can be removed and stowed by the ground crew prior to flight.

2 An ARMED/SAFE/EGRESS handle located on the right hand side of the ejection seat. Selection to the SAFE or EGRESS position will inhibit operation of the seat firing handle by means of an internal linkage within the ejection seat. The handle must be in the SAFE position during ingress.

Pulling the seat firing handle initiates a fully automatic ejection sequence, resulting in safe aircrew descent to the surface on a personal parachute.

If required, the seat will eject through the canopy with the aid of canopy penetrators, fitted to the top of parachute head-box, in the event of canopy jettison system failure. For additional information, refer to Canopy Jettison System pag. 1-297.

A microprocessor based sequencer is fitted to the seat to control the timing of drogue parachute deployment, the seat/man separation and personal parachute deployment. The timing is based on information provided by seat mounted sensors, which establish acceleration, airspeed and altitude during the ejection sequence. The sequencer is completely independent; powered by two thermal batteries which are initiated at the beginning of the ejection sequence.

In the event of sequencer failure a mechanical backup system is employed, controlled by a barostat and timer.

Personal Services

Personal services are provided to the aircrew via:

– Aircrew Services Package (ASP)
– Head Equipment Assembly Services Module (HEASM)
– Liquid Suit Connector Assembly (LSCA)
– Auxiliary Oxygen Bottle (AOB).

Aircrew Services Package

The ASP (Figure 1.135) is located on the left side of the seat pan and consists of a man portion, a seat portion and an aircraft portion. It provides the interface between the aircrew and the aircraft for breathing gas, NBC supply, anti-g trousers/flight jacket and communications (mic/tel).

During seat/aircraft separation, and subsequent seat/man separation, the ASP allows for disconnection of the above services. During seat/ aircraft separation, the aircraft portion is retained in the cockpit by a lanyard, attached to the cockpit floor. The man portion is released from the seat automatically during seat/man separation.

Head Equipment Assembly Services Module

The HEASM (not yet functional) is located on the right side of the seat pan (Figure 1.136). It consists of a man portion, a seat portion and an aircraft portion. It provides the interface for the Head Equipment Assembly (HEA), between the aircrew and the aircraft. The man and aircraft portions interface directly, via a multi-pin connector, to provide the helmet and HEASM tracker with power and the appropriate signals. During seat/aircraft separation, the aircraft portion is retained in the cockpit by a lanyard, attached to the cockpit floor. The man portion is released from the seat automatically during seat/man separation.

Liquid Suit Connector Assembly

The LSCA (not yet functional) is located on the right side of the seat pan (Figure 1.136) and consists of a man portion, a seat portion and an aircraft portion. It provides the interface between the liquid conditioning garment and the aircraft supply. During seat/aircraft separation, the aircraft portion is retained in the cockpit by a lanyard, attached to the cockpit floor. The man portion is released from the seat automatically at seat/man separation.

Auxiliary Oxygen

Auxiliary oxygen is provided by the AOB, which is mounted at the rear left side of the ejection seat. The AOB is available for emergency use at altitude, such as a Molecular Sieve Oxygen Concentrator (MSOC) failure or during the ejection sequence. For emergency purposes the auxiliary oxygen lever should be moved to the ON position. Upon initiation of ejection the AOB is automatically selected and the ASP breathing gas regulator is switched from the main supply to reversionary. When the AOB is selected, the MSOC supply is isolated at the ASP.

Personal Equipment

The personal equipment available to the aircrew is:

– NBC Ventilation Supply Package (VSP)
– Personal Survival Pack (PSP)
– Harness assembly
– Shoulder, leg and arm restraint system
– Personal parachute
– Aircrew Equipment Assembly (AEA)

NBC Ventilation Supply Package

The NBC VSP is mounted on the rear right side of the ejection seat, adjacent to the AOB. Its function is to provide a supply of filtered gas for ocular protection and demist of the HEA NBC respirator.
Under normal circumstances gas is sourced from the MSOC, but when necessary filtered cabin air is supplied via a fan filter assembly within the VSP.

Personal Survival Pack

The PSP (Figure 1.136) is a rigid 14 liter container which contains the various aircrew survival aids, as defined by the likely survival scenario. During ingress the aircrew must insert a PSP connector (located on a line from the flight jacket) into a sticker clip on the left side of the seat pan (Figure 1.135). This forms the interface between the aircrew and the PSP via a lowering line. During the ejection sequence, at seat/man separation, the PSP connector is pulled from the sticker clip but remains connected to the flight jacket and lowering line.
The PSP also contains an automatic inflation unit to inflate the life raft, should the ejectee land in water. Upon immersion in salt water the raft will inflate in 3 seconds; 7 seconds in fresh water. If automatic inflation fails, manual inflation is possible by use of a handle located on the underside of the PSP.

Harness Assembly

The seat is fitted with a restraint/parachute harness assembly (Figure 1.136), which in addition to the shoulder straps, is adjustable to cater for the anthropometric occupant range.
Two adjustable shoulder straps connect to the Quick Release Fitting (QRF), at the end of the negative-g strap, to close the harness loop. For additional information, refer to Strapping in and Unstrapping pag. 2-5.

Shoulder, Leg and Arm Restraint Systems

Upon ejection initiation the seat occupant is positioned and restrained in the optimum ejection posture by the Harness Power Retraction Unit (HPRU), which will remain locked regardless of the go-forward lever setting.
During ejection the seat also provides automatic restraint of the aircrew's arms and legs, to prevent flailing. Arm restraint lines on the flight jacket/ coverall attach to the QRF through tensioning loops. Each tensioning loop arrangement comprises a metalic portion which is clipped into the QRF, and a webbing/ply-tears arrangement which is attached to the cockpit floor. As the seat rises during ejection, the tensioning loops are pulled out of the QRF and then are pulled down, relative to the seat, which in turn applies a load to the arm restraints. At a predetermined load the ply-tears fail. The arms

restraints are then locked into the seat, restraining the arms, until man/seat separation.

A passive restraint system is provided for the legs, which eliminates the need for the aircrew to attach leg restraint lines. These restraint lines are routed from each thigh guard, around the leg tunnels and back onto the seat. As the seat moves upwards during ejection the lines become progressively taut, restraining the legs. At a predetermined load the ply-tears fail. The leg restraints are then locked into the seat, restraining the legs, until man/seat separation.

Personal Parachute

The personal parachute is a GQ type 5000, which has a 6.5m aeroconical canopy. It is packed into the head-box (Figure 1.136) and is deployed such to achieve a fully open parachute in the shortest possible time. The parachute's direction of flight may be altered via two steering lines. Water deflation pockets on the canopy assist deflation after landing in water, in order to prevent the aircrew being dragged.

Aircrew Equipment Assembly

The ejection seat interfaces with the AEA to provide the following functions:

- Safe automatic arm restraint upon ejection
- Automatic PLB activation during the ejection sequence
- Aircrew attachment to the PSP
- Safe body restraint
- Helmet/head-pad impact attenuation.

Ejection Seat Propulsion

Ejection seat propulsion is provided initially by ejection guns, followed by an Underseat Rocket Motor (USRM).

Ejection Guns

The seat is ejected by the action of gas pressure developed inside a twin ejection gun when the gun cartridge is fired. As the ejection gun reaches the end of its stroke the USRM is fired to sustain the momentum of the seat.

Underseat Rocket Motor

The USRM is attached to the underside of the seat pan. It contains solid fuel propellent and a gas operated igniter cartridge. It also incorporates a pair of eflux nozzles at each end of the rocket motor body.

The rocket motor eflux nozzles on the front and rear ejection seats are angled for divergence.

The USRM igniter cartridge is initiated by gas from dual Multipurpose Initiators (MPI), which are triggered at the end of the ejection gun stroke. The thrust from the USRM is sufficient to propel the seat to a sufficient altitude for safe recovery following a ground level, zero speed ejection, and to clear the fin of the aircraft during high speed ejection.

Ejection Seat Stabilization

Ejection seat stabilization is achieved by aerodynamic surfaces and a stabilizing drogue.

Aerodynamic Surfaces

Upon ejection the seat initially maintains a stable attitude by the use of three aerodynamic surfaces (Figure 1.135 and Figure 1.136). The two lower aero-surfaces are mounted on each side of the seat pan and the upper aero-surface is mounted on the head-box. These are deployed automatically and simultaneously by gas pressure from the MPI. Yaw stabilization is achieved by the lower aero-surfaces and stabilization in pitch is achieved by all three.

Stabilizing Drogue

A retarding and stabilizing ribbon drogue provides stability, supplementary to the aerodynamic stabilizers. The drogue is attached to the rear of the seat by a three point bridle, which ensures the seat faces the direction of travel. To allow the seat to align with the parachute raisers, before seat/man separation, the three point bridle is released sequentially; lower points at parachute deployment and the upper point at seat/man separation.

1 LH PITOT NOZZLE
2 LH HEADSPRAY AND NOZZLE
3 LH EJECTION GUN TOP LATCH
4 LH BOOSTER ASSEMBLY (T/S ONLY)
5 LH EJECTION GUN AUXILIARY CARTRIDGE
6 MAN PORTION ASP
7 ASP
8 PSP LOWERING LINE STICKER CLIP
9 MSOC MANIFOLD
10 LH LOWER AEROSURFACE (STOWED)
11 AUXILIARY OXYGEN SYSTEM OPERATING HANDLE
12 MAIN GUN CARTRIDGE
13 LH PASSIVE LEG RESTRAINT LINE
14 RH COMBINED GUILLOTINE AND SNUBBER UNIT
15 RH ARM RESTRAINT LINE
16 RH LAP STRAP
17 BACKPAD
18 HEADPAD
19 LH CANOPY PENETRATOR

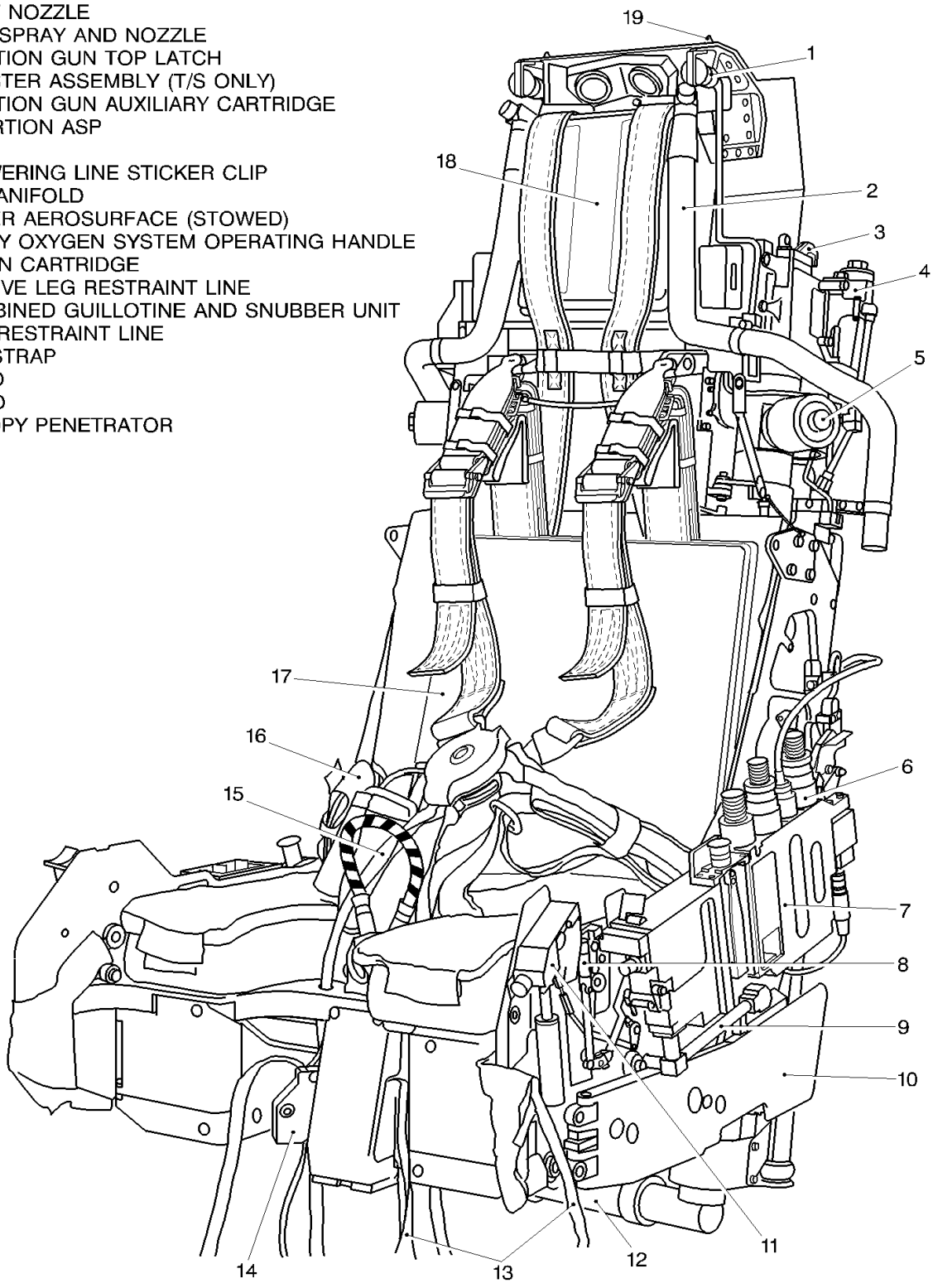


Figure 1.135 - Ejection Seat (Left Side)

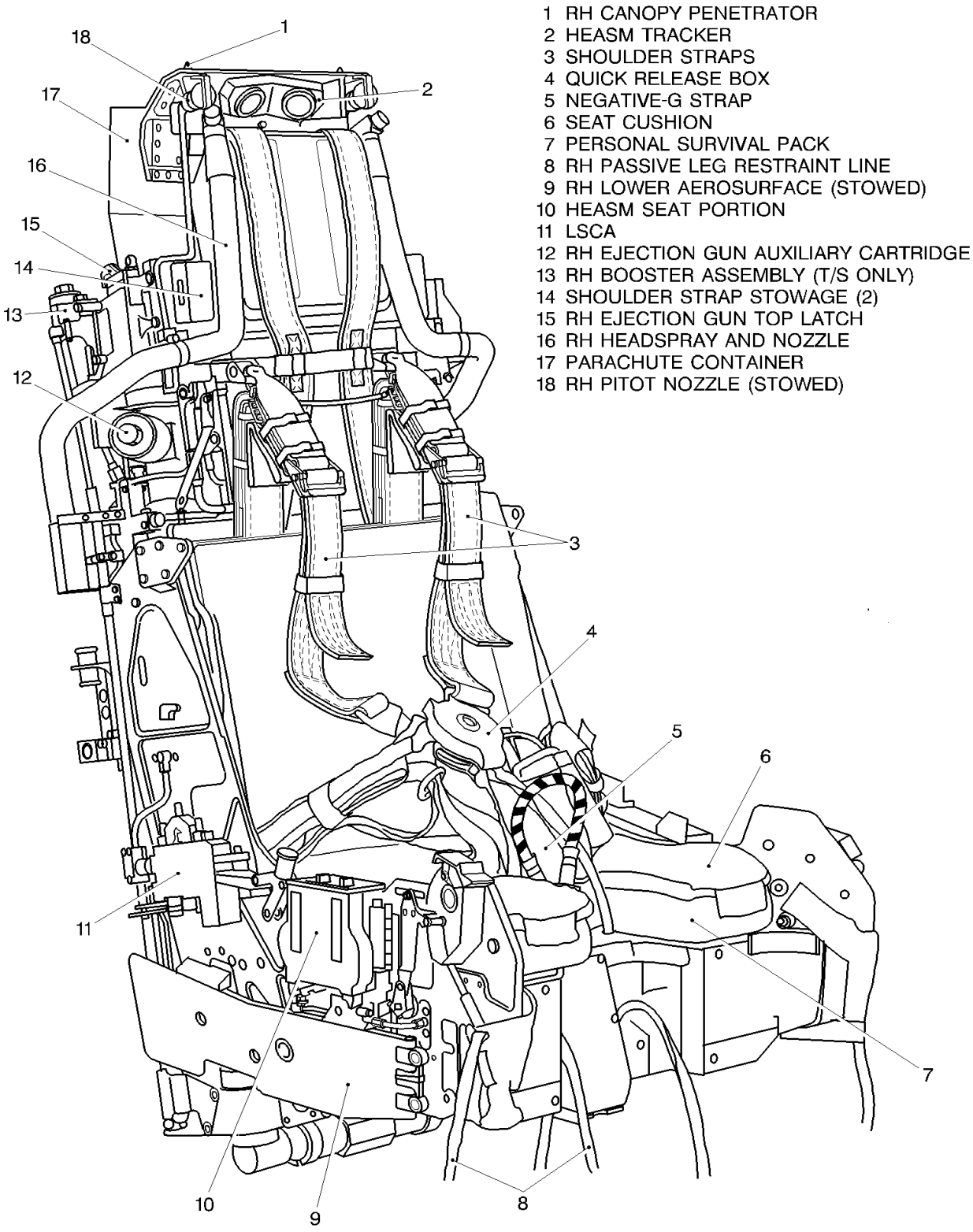

1 RH CANOPY PENETRATOR
2 HEASM TRACKER
3 SHOULDER STRAPS
4 QUICK RELEASE BOX
5 NEGATIVE-G STRAP
6 SEAT CUSHION
7 PERSONAL SURVIVAL PACK
8 RH PASSIVE LEG RESTRAINT LINE
9 RH LOWER AEROSURFACE (STOWED)
10 HEASM SEAT PORTION
11 LSCA
12 RH EJECTION GUN AUXILIARY CARTRIDGE
13 RH BOOSTER ASSEMBLY (T/S ONLY)
14 SHOULDER STRAP STOWAGE (2)
15 RH EJECTION GUN TOP LATCH
16 RH HEADSPRAY AND NOZZLE
17 PARACHUTE CONTAINER
18 RH PITOT NOZZLE (STOWED)

Figure 1.136 - Ejection Seat (Right Side)

Ejection Seat

(1B-B-95-10-00-00A-111A-A Issue 003)

Introduction

The ejection seat controls are as follows:

– Seat firing handle
– ARMED/SAFE/EGRESS handle
– Auxiliary oxygen lever
– Aircrew Services Package (ASP) controls
– Go-forward lever
– Seat raise/lower switch

Seat Firing Handle

The seat firing handle (Figure 1.137) is a black and yellow striped grab handle, mounted at the front of the seat pan, which is readily accessible to the aircrew without interference from the Aircrew Equipment Assembly (AEA) or aircraft controls.

ARMED/SAFE/EGRESS Handle

The seat ARMED/SAFE/EGRESS (Figure 1.137) handle is located on the right side of the seat pan and is in clear view of both ground-crew and aircrew. The handle is used for normal or emergency egress to make the seat safe when the aircraft is on the ground. When ARMED or SAFE is selected, the handle is locked into position by a latch which is released by a lever inside the handle. When the handle is in the SAFE or EGRESS position, a mechanical interlock prevents the seat firing handle being accidentally pulled from its housing.
When the handle is in the SAFE position the seat is safe and the seat firing handle cannot be accidently pulled; the visible portion of the handle is colored white and engraved (SAFE) in black. With the handle in the ARMED position ejection may be initiated; the visible portion of the handle is colored red and white and engraved (ARMED) in black. For manual or emergency egress when the aircraft is on the ground, the handle should be rotated beyond the SAFE position to the EGRESS position. When the handle is in this position the word EGRESS lines up with a yellow marker on the thigh guard; the visible portion of the handle is colored yellow and engraved (EGRESS) in black.
Locking the handle in the EGRESS position disconnects the ASP man portion, the flight jacket arrowhead connector from the Personal Survival Package (PSP) lowering line connector and the LSCA man portion.

Auxiliary Oxygen Lever

The auxiliary oxygen lever (Figure 1.137) is a two position, black and yellow lever and is located on the left seat pan thigh guard. Auxiliary oxygen may be selected by rotating the lever towards the pilot to the ON position. At the end of lever travel, the lever locks in the ON position. De-selection of the auxiliary oxygen supply is acheived by pressing the release button on the end of the lever and lowering the lever fully to the OFF position. Should the AOB be selected automatically an amber MSOC warning is displayed on the Dedicated Warnings Panel (DWP), an accompanying audio warning is generated, and the AOB contents is displayed on the MHDD/PA format.Manually selecting the AOB to ON also selects the ASP regulator to reversionary (REV). When the pilot resets the AOB to OFF, the regulator will remain in the REV position, and must be manually reselected to MAIN.
When the contents of the AOB decreases to 70 liters, or fails upon automatic selection the following occur:

– A red OXY warning is displayed on the DWP
– A audio tone is generated
– The AOB contents (MHDD/PA format) is shown on a red background.

Under conditions of automatic selection failure the AOB is to be selected manually.

Aircrew Services Package Controls

The ASP controls (Figure 1.137) consist of the following:

– PTT button
– Main/reversionary selector
– Anti-g valve on/off selector.

The PTT switch is used to ensure that the anti-g trousers and flight jacket inflate and that the breathing gas pressure increases for positive pressure breathing.
The MAIN/REV selector is a two position switch, which is normally set to MAIN. It can be selected to REV manually, via the switch, or automatically when the AOB is selected. When set to the REV, position the breathing gas pressure is higher than usual; providing the aircrew with a further indication that REV is selected.
The anti-g valve ON/OFF selector is two position selector which is usually set to the ON position. In this position the anti-g supply is provided to the anti-g trousers and allows positive pressure breathing when necessary. To select the OFF position the selector must first be lifted.

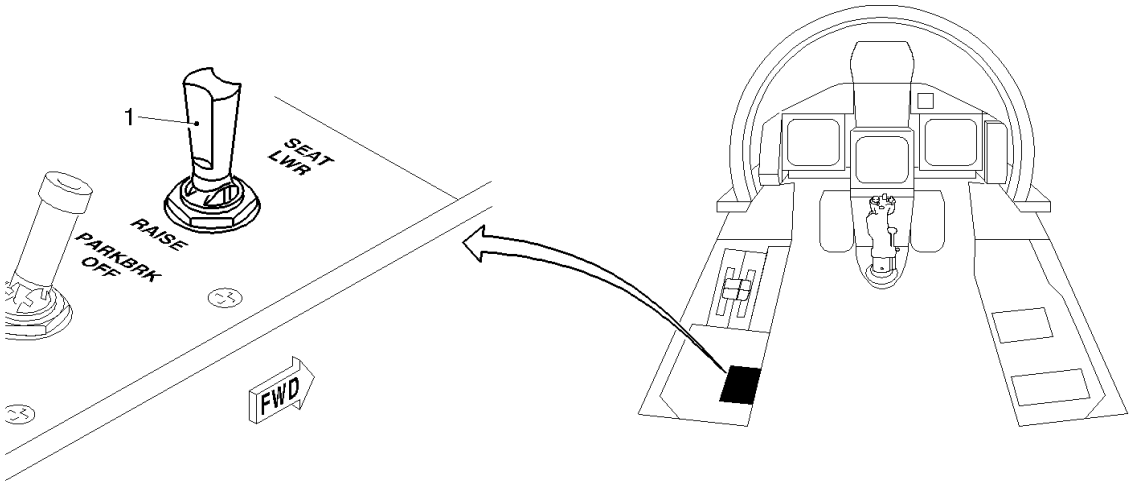
Go-forward Lever

The harness go-forward lever (Figure 1.137) is a two position lever located on the right side of the seat pan. In the forward (free) position it allows the aircrew to move forward and twist round in the seat. If the straps are extended rapidly due to sudden deceleration, with the lever in this position, the

Harness Power Retraction Unit (HPRU) locks and prevents further extension until the load on the straps is released. With the lever in the aft (locked) position, the straps will retract but not extend.

Seat Raise/Lower Switch

The seat raise/lower switch is a three position switch, located at the rear of the left console (Figure 1.137). The switch is biased to the center (null) position. Movement of the switch to the forward/aft position lowers/raises the seat, respectively.



1 SEAT RAISE/LOWER SWITCH
2 ARMED/SAFE/EGRESS HANDLE
3 GO-FORWARD LEVER
4 SEAT FIRING HANDLE
5 AUXILIARY OXYGEN LEVER
6 ANTI-G VALVE SELECTOR
7 PRESS TO TEST BUTTON
8 MAIN/REVERSIONARY SELECTOR

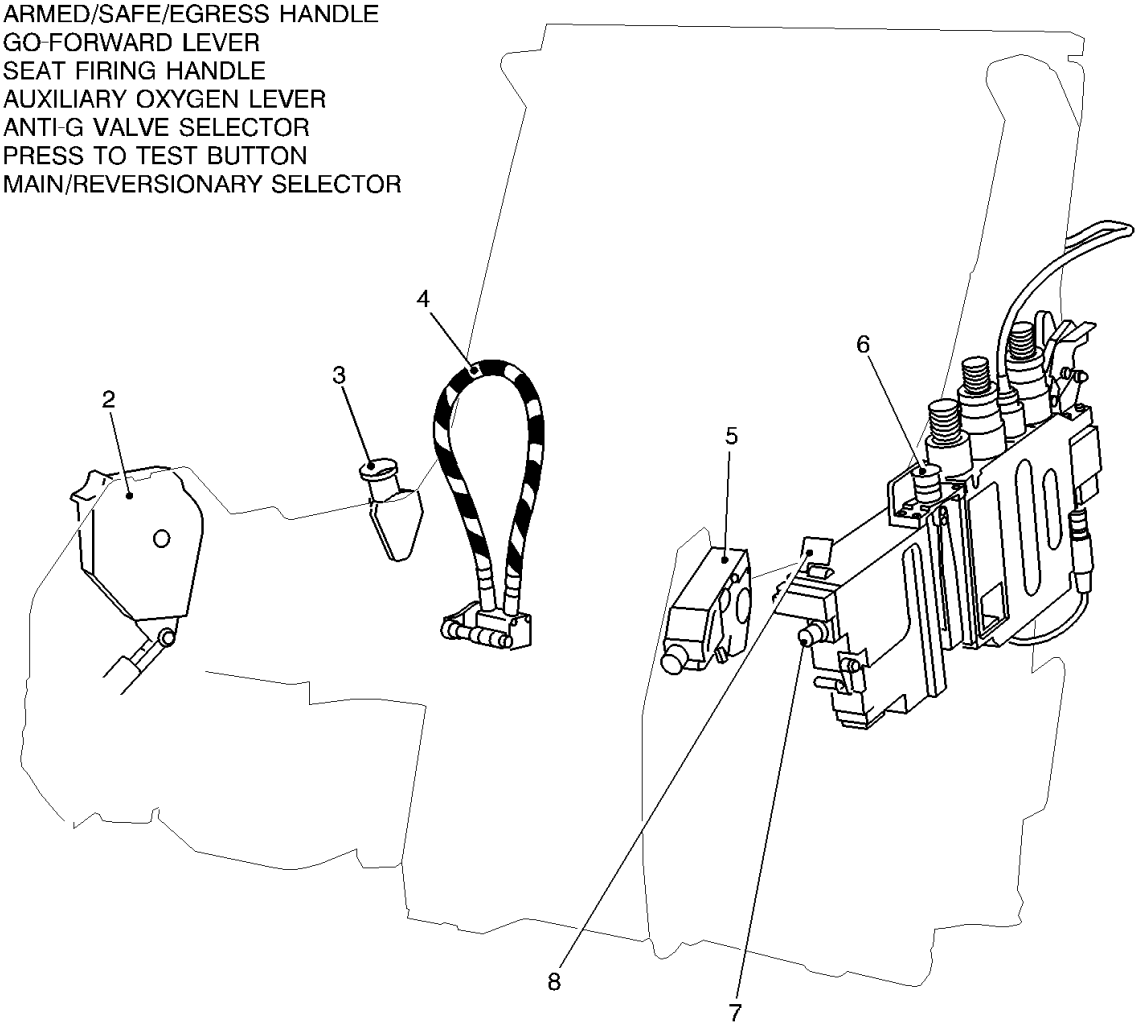


Figure 1.137 - Associated Ejection Seat Controls

Ejection Sequence

(1B-B-95-10-01-00A-043A-A Issue 003)

Introduction

Pulling the front or rear ejection seat firing handle initiates an ejection sequence. This action removes sears from two firing units in a double breech on the underside of the respective seat pan. This fires the two cartridges, thus initiating the ejection sequence. Upon initiation of ejection a set sequence of events occur. Once the ejected seat is away from the aircraft the sequence that follows is dependent upon that seat's speed and altitude.

To allow for different aircraft roles, i.e. training, passenger transport or solo flight, a command firing system is provided. This allows the order of seat ejection to be altered for the required role. The system is set from the rear cockpit, via a Command Mode Selector (CMS).

Command Firing System

The aircraft is fitted with a combined canopy jettison and command ejection system. Mode selection is usually made before flight, but in-flight adjustment is possible. Selection is made via a CMS located to the rear of the right console in the rear cockpit (Figure 1.138). This selector is a three position lever, locked by a screw top. The three positions are SOLO, BOTH and FRONT. The screw top must first be completely unscrewed before an alternative selection may be made. Lever unlock is indicated by the extension of a red telltale indicator, from the lever top. Once unlocked a spring-loaded collar, on the lever, must be lifted to allow alternative selection.

Solo Selection

The solo selection is intended for use when the rear seat is unoccupied. Ejection initiation from the front cockpit jettisons the canopy immediately, and the front seat is ejected after a short delay; the rear seat remains. The delay ensures safe separation of canopy and seat.

Both Selection

Ejection initiation from either cockpit will jettison the canopy immediately, and the rear seat is ejected after a short delay, followed by the front seat after a further short delay.

Front Selection

This mode provides two alternatives:

– Front seat initiation
– Rear seat initiation

Ejection initiation from the front cockpit will jettison the canopy immediately, and the rear seat is ejected after a short delay, followed by the front seat after a further short delay.

Ejection initiation from the rear cockpit will jettison the canopy immediately, and the rear seat only is ejected after a short delay. The front seat may be ejected later, if necessary.

Pre-Aircraft/Seat Separation Sequence

Gas from the left/right cartridge is used to:

– Initiate the canopy jettison system via a quick-disconnect
– Activate the auxiliary oxygen system
– Disconnect the electrical and crypto-erase connectors
– Pull the aircrew back into the correct position for ejection, via the harness reel
– Initiate the left/right seat sequencer thermal batteries, respectively
– Initiate the ejection gun
– Initiate the left/right time delay mechanism respectively, in the dual timer on the ejection gun cartridge.

After either of the time delays on the ejection gun cartridge has run out, the firing pin is released and the cartridge initiated. The gas pressure developed by the ejection cartridge causes the top latches of the seat to unlock and the ejection gun assembly to rise. As the seat rises up the guide tubes the following occurs:

– The seat/canopy jettison system interface is disconnected
– The Head Equipment Assembly Services Module (HEASM) aircraft portion is disconnected
– The Aircrew Services Package (ASP) aircraft portion is disconnected
– The Liquid Suit Connector Assembly (LSCA) aircraft portion is disconnected
– The leg and arm restraint lines become progressively taut
– The tear webbing separates from the anchorage points on the aircraft floor
– The applied leg and arm restraint is maintained by the Combined Snubber/Guillotine Unit (CSGU).

At the end of the ejection gun stroke, the left and right Multipurpose Initiators (MPI) are tripped.

Post-Aircraft/Seat Separation Sequence

The left/right MPI provide gas pressure to enable the following:

– The opening of the left/right start switch to deploy the left/right pitot, respectively, which activates the electronic sequencer
– Ignition of the Underseat Rocket Motor (USRM) to sustain the upward thrust of the ejection gun to carry the seat clear of the aircraft
– Initiation of the cartridge of the aerodynamic surface deployment unit under the seat pan. This deploys the lower aero-surfaces, which help to stabilize the seat, in conjunction with the upper aero-surface; particularly during high speed ejection.

The left MPI also provides gas pressure to enable:

– The deployment of the upper aero-surface on the parachute head-box
– The tripping of the time delay mechanism in the barostatic backup unit.

Electronic Sequencer Timing

Electronic sequencer timing begins when the start switches open. The sequencer senses altitude and airspeed parameters via the pitots and accelerometers. Skewed axis accelerometers, within the sequencer, provide a second source of data.
The sensed information is used by the sequencer to determine the appropriate sequence for descent to the surface. One of three modes is selected:

– Immediate
– Low drogue
– High drogue.

The timing in each mode is such that safe parachute deployment is executed at the earliest possible time.

Immediate Mode (Low Speed, Low/Medium Altitude)

In this mode (Figure 1.139) event timing is fixed and the drogue is not deployed or released. The head-box is released and the main parachute deployed at the earliest practicable opportunity, nominally 0.27 seconds from aircraft/seat separation, to place the aircrew on to the parachute. The harness release system operates 0.18 seconds later to free the aircrew from the seat.

Low Drogue Mode (Medium/High Speed, Low/ Medium Altitude)

In this mode (Figure 1.140) the drogue deployment unit fires to deploy the drogue, nominally 0.16 seconds after aircraft/seat separation. As soon as the sequencer senses that the airspeed is below a given limit the drogue bridle and drogue are released and the head-box is released to place the aircrew on the parachute. The drogue is released 0.13 seconds later, and the harness release system operates after a further 0.05 seconds to free the aircrew from the seat.

High Drogue Mode (Any Speed/High Altitude)

In this mode (Figure 1.141) the drogue deployment unit fires to deploy the drogue, nominally 0.16 seconds after aircraft/seat separation. The drogue bridle remains connected until the seat has descended, face down, to 16 400ft (5000m). This arrangement prevents prolonged exposure to low temperature and rarefied air, and allows the aircrew to descend with the seat as quickly as possible to a tolerable altitude; stabilized by the drogue and supplied with oxygen. When the seat has descended to the correct height the drogue bridle and drogue are released, and the head-box is released to place the aircrew on the parachute. The drogue is released 0.13 seconds later, and the harness release system operates after a further 0.05 seconds to free the aircrew from the seat.

Man/Seat Separation

At man/seat separation the ejectee is momentarily held in the seat by sticker clips to ensure clean separation.
Depending on the setting of the Automatic Deployment Unit (ADU) (MAN or AUTO) prior to ejection, the Personal Survival Pack (PSP) may or may not be automatically lowered after man/seat separation. If the AUTO setting was selected then the PSP is lowered, on its lowering line, 4 seconds after separation. If the MAN setting was selected then this provides the aircrew with the option to manually lower the PSP whilst on the parachute or, alternatively, keep it in position.

Backup Sequencer Timing

A barostatic backup unit is used in the event of an electronic sequencer failure. The backup unit contains a 4 second time delay mechanism, which is armed by gas pressure from the left MPI during the ejection sequence. The timing sequence begins when an altitude of <16 400ft is sensed. After the delay a cartridge is fired, supplying gas pressure to operate the head-box deployment unit, the bridle release cartridge and the harness release system.

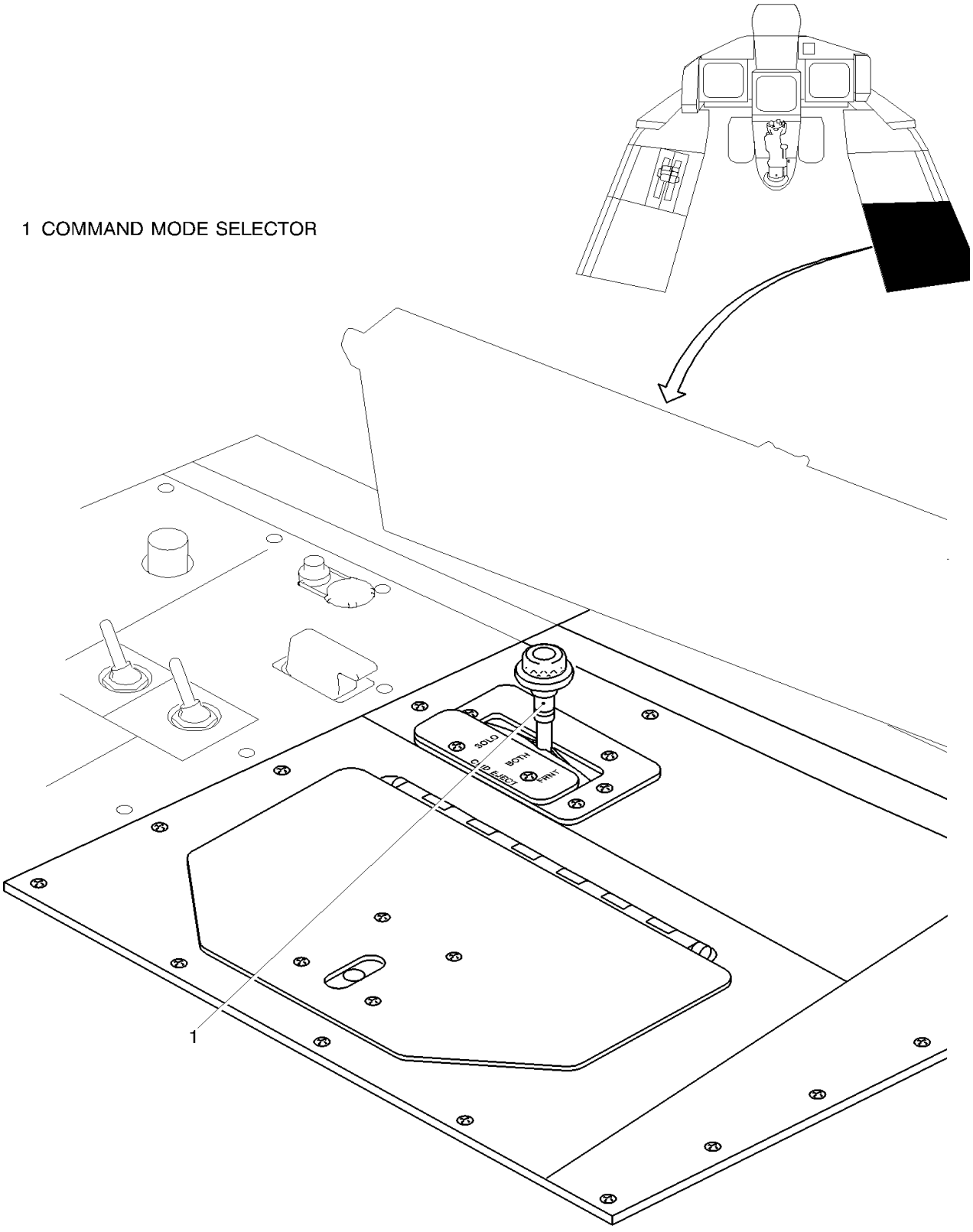
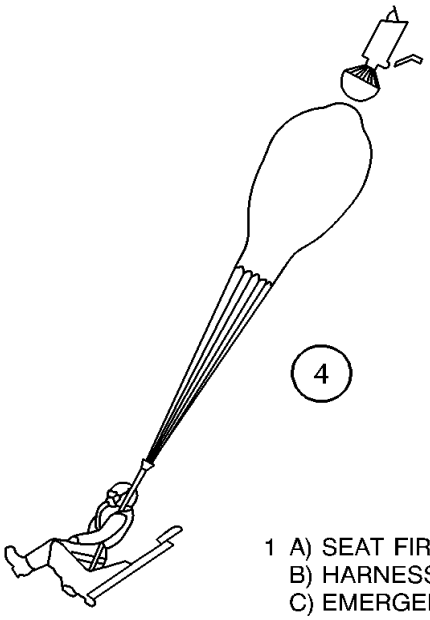
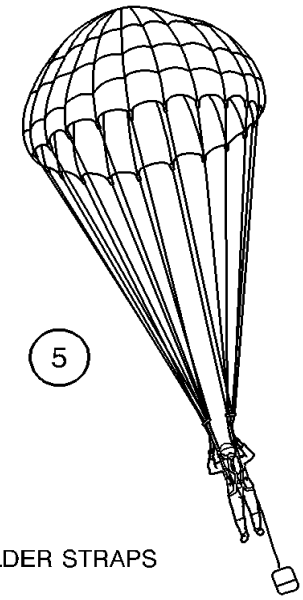
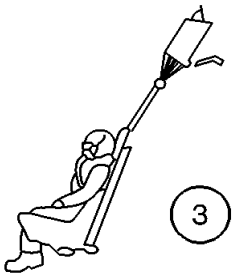
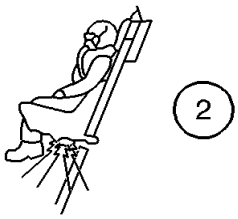


Figure 1.138 - Command Mode Selector









1 A) SEAT FIRING HANDLE PULLED
B) HARNESS REEL RETRACTS SHOULDER STRAPS
C) EMERGENCY OXYGEN ACTIVATED
D) AGVSS INITIATED (ASP VARIANT ONLY)
E) ELECTRICAL CONNECTOR DISCONNECTED
F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
*G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
J) EJECTION GUN TIME DELAYS INITIATED
K) EJECTION GUNS INITIATED AFTER DELAY
L) EJECTION GUN TOP LATCHES DISENGAGE
M) EJECTION GUN BOTTOM LATCHES ENGAGE
N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

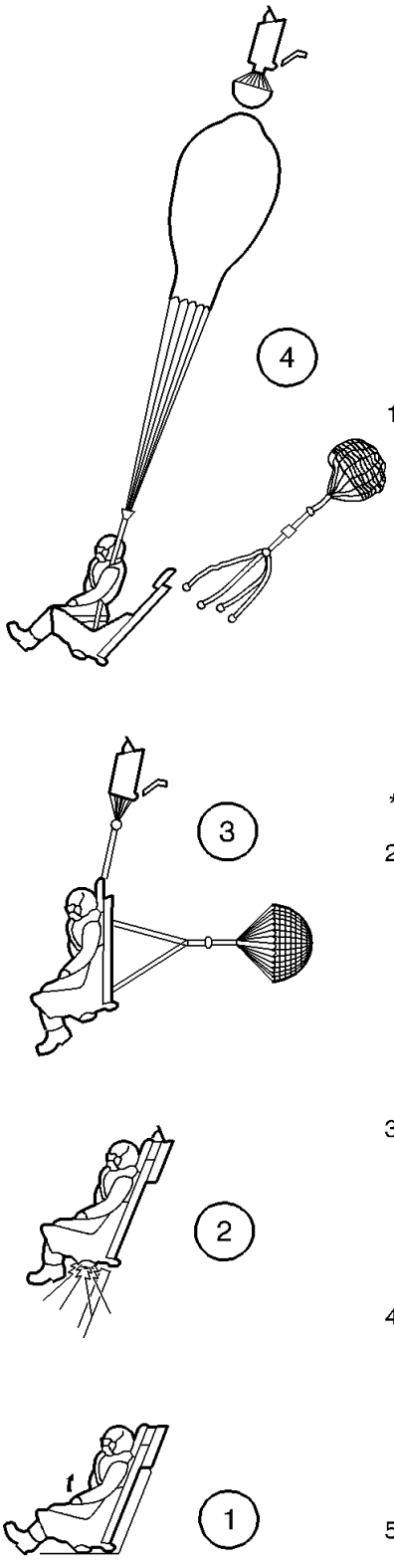
2 A) SERVICES DISCONNECT
B) LEG AND ARM RESTRAINTS OPERATE
C) MULTI-PURPOSE INITIATORS FIRE
D) END OF EJECTION GUN STROKE
E) UNDERSEAT ROCKET MOTOR FIRES
F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
G) PITOTS DEPLOY
H) BAROSTATIC BACK-UP UNIT INITIALISED
J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

3 A) SEQUENCER SENSES LOW SPEED AND LOW ALTITUDE
B) SEQUENCER SELECTS IMMEDIATE MODE
C) HEADBOX DEPLOYMENT UNIT OPERATES

4 A) PARACHUTE DEPLOYS AND BEGINS INFLATION
B) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
C) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
D) PERSONAL LOCATOR BEACON ACTIVATED
E) PSP RETAINED
F) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

5 A) PILOT DESCENDS ON PARACHUTE
B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.139 - Low Speed, Low/Medium Altitude



1 A) SEAT FIRING HANDLE PULLED
B) HARNESS REEL RETRACTS SHOULDER STRAPS
C) EMERGENCY OXYGEN ACTIVATED
D) AGVSS INITIATED (ASP VARIANT ONLY)
E) ELECTRICAL CONNECTOR DISCONNECTED
F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
*G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
J) EJECTION GUN TIME DELAYS INITIATED
K) EJECTION GUNS INITIATED AFTER DELAY
L) EJECTION GUN TOP LATCHES DISENGAGE
M) EJECTION GUN BOTTOM LATCHES ENGAGE
N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

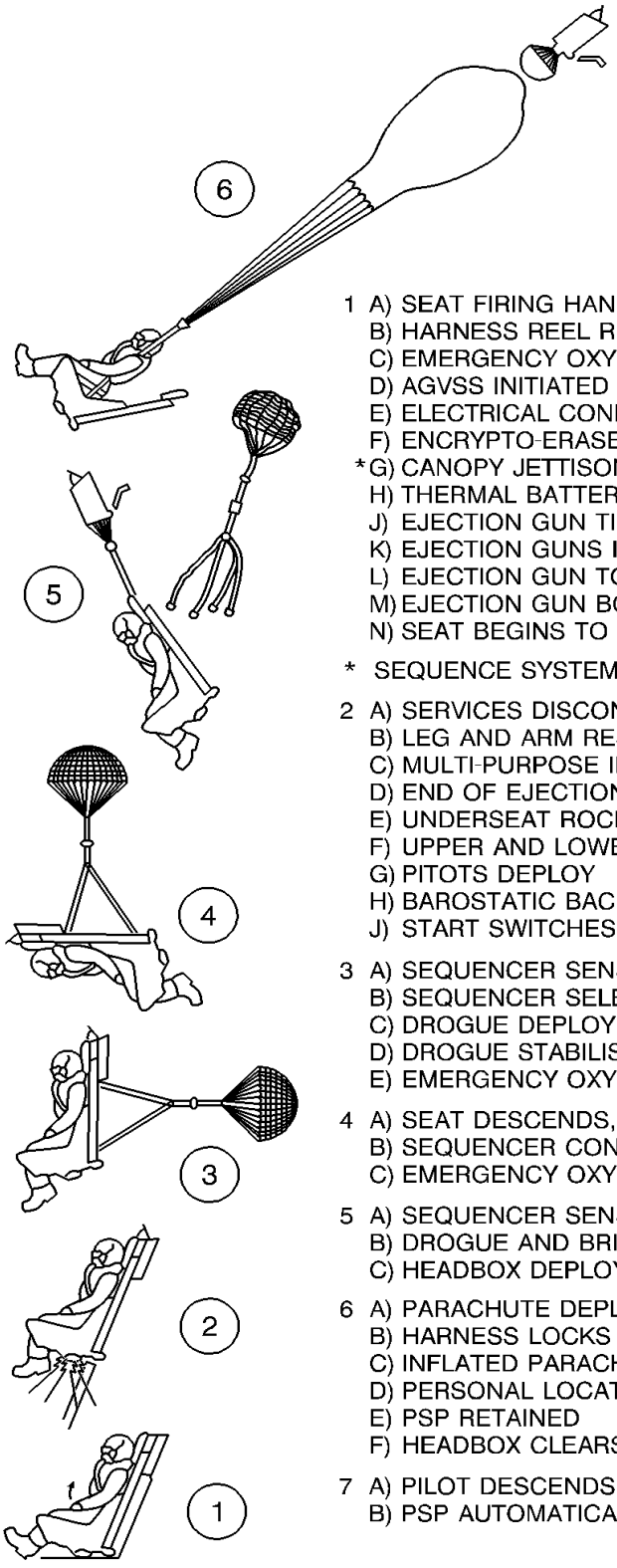
2 A) SERVICES DISCONNECT
B) LEG AND ARM RESTRAINTS OPERATE
C) MULTI-PURPOSE INITIATORS FIRE
D) END OF EJECTION GUN STROKE
E) UNDERSEAT ROCKET MOTOR FIRES
F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
G) PITOTS DEPLOY
H) BAROSTATIC BACK-UP UNIT INITIALISED
J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

3 A) SEQUENCER SENSES HIGH SPEED AND LOW ALTITUDE
B) SEQUENCER SELECTS DROGUE MODE
C) DROGUE DEPLOYMENT UNIT OPERATES
D) SEQUENCER RESTARTS ENVIROMENTAL SENSING AFTER DELAY
E) HEADBOX DEPLOYMENT UNIT OPERATES WHEN SPEED SUFFICIENTLY REDUCED

4 A) DROGUE AND BRIDLE RELEASED
B) PARACHUTE DEPLOYS AND BEGINS INFLATION
C) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
D) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
E) PERSONAL LOCATOR BEACON ACTIVATED
F) PSP RETAINED
G) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

5 A) PILOT DESCENDS ON PARACHUTE
B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.140 - Medium/High Speed, Low/Medium Altitude



1 A) SEAT FIRING HANDLE PULLED
B) HARNESS REEL RETRACTS SHOULDER STRAPS
C) EMERGENCY OXYGEN ACTIVATED
D) AGVSS INITIATED (ASP VARIANT ONLY)
E) ELECTRICAL CONNECTOR DISCONNECTED
F) ENCRYPTO-ERASE CONNECTOR DISCONNECTED
*G) CANOPY JETTISON AND SEQUENCE SYSTEM INITIATED
H) THERMAL BATTERIES ACTIVATED AND SQUENCER POWERED UP
J) EJECTION GUN TIME DELAYS INITIATED
K) EJECTION GUNS INITIATED AFTER DELAY
L) EJECTION GUN TOP LATCHES DISENGAGE
M) EJECTION GUN BOTTOM LATCHES ENGAGE
N) SEAT BEGINS TO MOVE UP GUIDE TUBES

* SEQUENCE SYSTEM TWIN SEAT AIRCRAFT ONLY

2 A) SERVICES DISCONNECT
B) LEG AND ARM RESTRAINTS OPERATE
C) MULTI-PURPOSE INITIATORS FIRE
D) END OF EJECTION GUN STROKE
E) UNDERSEAT ROCKET MOTOR FIRES
F) UPPER AND LOWER AERODYNAMIC SURFACES DEPLOYED
G) PITOTS DEPLOY
H) BAROSTATIC BACK-UP UNIT INITIALISED
J) START SWITCHES OPEN TO BEGIN SEQUENCER OPERATION

3 A) SEQUENCER SENSES HIGH ALTITUDE (ANY SPEED)
B) SEQUENCER SELECTS HIGH DROGUE MODE
C) DROGUE DEPLOYMENT UNIT OPERATES
D) DROGUE STABILISES AND DECELERATES SEAT
E) EMERGENCY OXYGEN SUPPLY CONTINUED

4 A) SEAT DESCENDS, STABILISED BY DROGUE
B) SEQUENCER CONTINUES TO SENSE ALTITUDE
C) EMERGENCY OXYGEN SUPPLY CONTINUED

5 A) SEQUENCER SENSES PARACHUTE DEPLOYMENT ALTITUDE
B) DROGUE AND BRIDLE RELEASED
C) HEADBOX DEPLOYMENT UNIT OPERATES

6 A) PARACHUTE DEPLOYS AND BEGINS INFLATION
B) HARNESS LOCKS AND PEC/LSCA MAN PORTIONS RELEASED
C) INFLATED PARACHUTE PULLS OCCUPANT FROM SEAT
D) PERSONAL LOCATOR BEACON ACTIVATED
E) PSP RETAINED
F) HEADBOX CLEARS EJECTION PATH USING AUXILIARY DROGUE

7 A) PILOT DESCENDS ON PARACHUTE
B) PSP AUTOMATICALLY LOWERED AFTER 4 SECONDS

Figure 1.141 - Any Speed, High Altitude

Minimum Ejection Heights

(1B-B-95-10-02-00A-043A-A Issue 004)

The Mk 16A seat is cleared for operation at all heights from zero altitude to 55 000 ft and from zero to 600 KCAS or Mach 2, whichever is the lower.

The minimum ejection heights shown in Table , “Safe Terrain Clearance Limits,” on page 1-293 are from ejection gun initiation and exclude the seat time delays on twin seat aircraft.

The data presented applies to ISA sea level atmospheric conditions. Altitude effects on seat performance require that terrain clearance must be increased by 2% for every 100 ft above sea level.

Safe Terrain Clearance Limits

AIRCRAFT VELOCITY CONDITIONS			WORSE CASE VERTICAL CLEARANCE REQUIRED BETWEEN AIRCRAFT AND GROUND LEVEL (FT) AT AIRCRAFT BANK ANGLES OF:			
AIRSPEED (KDAS)	DIVE ANGLE	SINK RATE (FT/MIN)	0°	45°	90°	180°
0	0	0	0	23	181	315
		2000	81	95	209	355
		6000	154	179	332	440
		10 000	206	301	399	527
130	0	0	0	0	118	257
		2000	0	40	168	306
		6000	102	144	260	388
		10 000	202	254	353	448
225	0	0	0	0	73	166
		2000	2	40	114	199
		6000	79	125	196	279
		10 000	178	204	272	340
450	0	0		AWAITING		
		2000		INFORMATION FROM		
		6000		MARTIN BAKER		
		10 000		FOR 450 (KDAS)		
600	0	0	7	41	99	180
		2000	55	66	133	213
		6000	141	169	236	301
		10 000	226	260	321	380
50	20		0	62	217	366

AIRCRAFT VELOCITY CONDITIONS			WORSE CASE VERTICAL CLEARANCE REQUIRED BETWEEN AIRCRAFT AND GROUND LEVEL (FT) AT AIRCRAFT BANK ANGLES OF:			
AIRSPEED (KDAS)	DIVE ANGLE	SINK RATE (FT/MIN)	0°	45°	90°	180°
0	30		0	62	183	323
	60		79	122	191	253
	90		178	178	178	178
130	30		117	179	289	403
	60		296	337	397	457
	90		420	420	420	420
225	30		213	249	312	383
	60		422	441	475	516
	90		531	531	531	531
450	30		466	476	574	651
600	30		665	690	738	793
	60		1153	1170	1197	1223
	90		1358	1358	1358	1358

The data does not directly take into account the Under Seat Rocket Motor (USRM) divergence effects on safe terrain clearances. This is addressed by use of bank angle correction value selected from the chart at Table , “Divergence Bank Angle Corrections,” on page 1-294 . This value is added to or subtracted from the actual bank angle, dependent on which direction the bank angle is acting in relation to the USRM divergence direction. Thus, if right bank is initiated and the URSM provides divergence to the left, then the correction angle is subtracted from the bank angle.

Divergence Bank Angle Corrections

AIRSPEED (KDAS)	CORRECTION ANGLE (DEG)
0	15
50	9.90
100	6.54
150	4.32
200	2.85
250	1.88
300	1.24
350	0.82
400	0.54
450	0.36
500	0.24

Aircrew Equipment Assembly

(1B-B-95-90-00-00A-043A-A Issue 002)

General

NOTE

SPA AEA to be issued at a later date

The Aircrew Equipment Assembly (AEA) system consists of garments and man mounted equipment, and interfaces with other aircraft systems to allow the aircrew to operate the aircraft effectively throughout the operating envelope. Additionally the AEA provides protection during escape and enhances the probability of survival prior to and during rescue. The AEA comprises both standard Government Furnished Equipment (GFE) and Eurofighter specific equipment.

Only those items that are appropriate to the mission need to be selected from the Eurofighter AEA. The Eurofighter AEA system differs from previous equipment in that each AEA function is performed by a distinct layer of garments.

Aircrew Equipment Assembly System

The Eurofighter AEA system is divided into two sub-systems, the Head Equipment Assembly (HEA) and flight clothing (including and associated equipment).

Head Equipment Assembly

The major components of the HEA are:

– Helmet
– Face mask
– Communications lead.

Helmet

The helmet provides head impact and ocular protection. In addition the helmet provides fitting adjustment and supports the face mask and earphones.

Face Mask

The face mask is attached to the helmet via bayonet fittings. The face mask attachment tension is manually adjustable and also has a quick release capability. The face mask also provides a voice activated microphone.

Communications Lead

The communications lead, for the earphones and facemask microphone, connects between the inner helmet and the Aircrew Services Package (ASP), aircrew portion.

Flight Clothing

There are three categories of flying clothes:

– Inner layer
– Intermediate layers
– Outer layer.

Inner Layer

The inner layer consists of under wear. This layer provides basic thermal protection and enhances comfort by absorbing sweat.

Intermediate Layers

The intermediate layer comprises a number of garments, some of which may be worn over others as follows:

Thermal Protection Garments (TPG): TPG are optional and are worn as the next layer over the underwear. There are three types:

– Shortie: This is a thermal coverall type garment with short sleeves and short legs.
– Longie: This is a thermal coverall type garment with long sleeves and long legs.
– Combie: This is a thermal coverall type garment long sleeves, long legs and an extra thick vest section.

Immersion Protection Garment (IPG) (UK & GE only): The IPG is an optional one piece garment, which includes socks. The garment

fabric is double layer nomex with a third, middle layer of Gore-Tex water proofing. The socks are made of a Gore-Tex stretch material and the upper arms incorporate cotton ventile patches to prevent ballooning and "shrink wrapping" during rapid changes in pressure. The IPG has pockets, water tight neck and wrist seals, and a urination zip. There are two types of IPG which are identical in all respects except for the way they fasten, these are:

- Horseshoe zip: The closure zip goes from the front torso, behind the neck and then back to the front torso.
- Cross chest zip (UK only): The closure zip is situated diagonally across the chest.

Interim IPG (UK only): This is the standard RAF `Mk1 immersion suit inner'.
Light Weight Coverall (LWC): The LWC is a one-piece garment of Nomex fabric, which may be worn as an outer garment on the ground and as an intermediate layer in flight.

Outer Layer

The major components of the outer layer are :

- Flight jacket
- Full coverage anti-G trousers (FCAGT)
- Integrated boots
- GFE boots
- Gloves.

Flight Jacket: The flight jacket consists of a long sleeved carrier waistcoat, which incorporates an inflatable chest counter pressure bladder (CCPB) and a life preserver assembly (LPA). The CCPB assists breathing during pressure breathing with G (PBG), and pressure breathing with altitude (PBA). The CCPB applies pressure on the chest to counteract the outward pressure due to the pressurized breathing gas. The LPA consists of an inflatable life preserver and an automatic inflation unit, which can also be manually activated. This is stowed in a pouch around the neck. The breathing gas hose assembly, (BGHA), is considered part of the flight jacket assembly. The BGHA has a compensated dump valve (CDV), which regulates the pressure applied by the CCPB. The sleeves have arm restraints, which prevent arm flailing during ejection. Sleeve pockets are provided to stow the arm restraint lines when they are not in use. The waistcoat portion of the flight jacket has pockets for the stowage of survival aids. The main closure zipper closes downwards to prevent it riding down during ejection.
Full Coverage Anti-G Trousers (FCAGT): The FCAGT contain bladders, which apply pressure over the lower abdomen and legs, excluding the crotch and buttocks. The FCAGT are supplied with air via a connection from the Aircrew Services Package (ASP) and are available in two types:

- Zippered: These are closed by zips down the inside of each leg.
- Step-in: These have no zips and are donned like normal trousers.

Integrated Boots: The integrated boots are flying boots which have inflatable bladders built into them to apply pressure to the feet. The boots have connectors to the FCAGT.
GFE Boots: GFE boots are flying boots without inflatable bladders.
Gloves: These are flying gloves.

Flight Operating Procedures

No part of the AEA should be removed during flight and the blast visor should always be in the down position. This ensures safety in the event of sudden emergency such as loss of cabin pressure or requirement to eject. Only specific actions such as the Valsalva maneuver or to clear the nasal passage, should both visors be raised and/or the mask be released.

Schedules

The GFE items may be selected from the drawings listed below:

- RDJ9590014 - GFE Flt Schedule - MK 16 Seat GE
- RDJ9590015 - GFE Flt Schedule - MK 16 Seat IT
- RDJ9590016 - GFE Flt Schedule - MK 16 Seat SP
- RDJ9590017 - GFE Flt Schedule - MK 16 Seat UK.

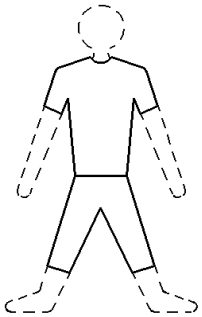
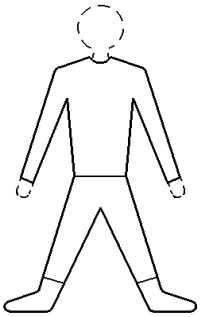
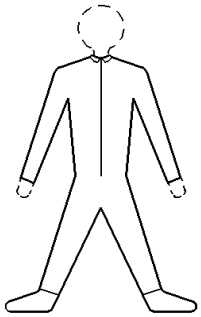
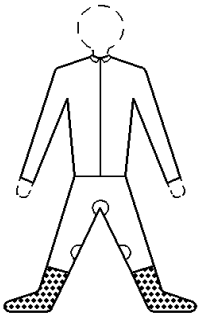
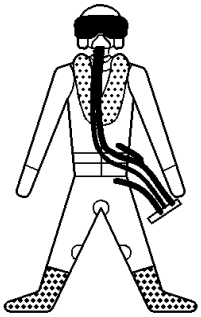
DONNING SEQUENCE / AEA SCHEDULE	1 	2 	3 	4 	5 
SUMMER LAND	LONG JOHNS VEST (optional)	SOCKS SHIRT SHORTIE(optional) LONGIE(optional) COMBIE(optional)	LIGHTWEIGHT COVERALL	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD - (optional)	FLIGHT JACKET SPECTACLES - (optional) GLOVES WATCH HEAD ASSEMBLY
SUMMER SEA	LONG JOHNS VEST (optional)	SOCKS SHIRT SHORTIE(optional) LONGIE(optional) COMBIE(optional)	IMMERSION PROTECTION GARMENT	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD - (optional)	FLIGHT JACKET SPECTACLES - (optional) GLOVES WATCH HEAD ASSEMBLY
WINTER LAND	LONG JOHNS VEST	SOCKS AT LEAST ONE OF THE FOLLOWING:- SHIRT SHORTIE LONGIE COMBIE	LIGHTWEIGHT COVERALL	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD - (optional)	FLIGHT JACKET SPECTACLES - (optional) GLOVES WATCH HEAD ASSEMBLY
WINTER SEA	LONG JOHNS VEST	SOCKS AT LEAST ONE OF THE FOLLOWING:- SHIRT SHORTIE LONGIE COMBIE	IMMERSION PROTECTION GARMENT	INTEGRATED BOOTS or BOOTS FCAGT KNEEBOARD - (optional)	FLIGHT JACKET SPECTACLES - (optional) GLOVES WATCH HEAD ASSEMBLY

Figure 1.142 - Donning Stages

Canopy Jettison System

(1B-B-95-20-00-00A-043A-A Issue 002)

Introduction

The canopy jettison system provides the primary means of escape path clearance. As part of an automatic escape sequence the canopy is released from the aircraft and driven away from the escape path by Canopy Jettison Rocket Motors (CJRMs) mounted on the forward canopy frame. Canopy jettison is initiated by gas signals received from the Ejection Seat(s), or by operation of the internal or external Canopy Jettison Handles, enabling independent canopy jettison. The handles enable canopy jettison in situations where the ejection seat is required to remain in the cockpit. For the location of the handles refer to Canopy Jettison System pag. 1-300.

System Operation

The canopy jettison system is shown in Fig 2. Two rocket motors are located on the front end of each canopy edge member. Controlled by the Canopy Jettison Manual Fired Initiator Unit (CJMFIU), two cartridges are fitted in the Canopy Jettison Gas Fired Initiator Unit (CJGFIU), one in each canopy emergency unlock cylinder and one in each rocket motor.

WARNING

THE CANOPY JETTISON SYSTEM IS A POTENTIAL SOURCE OF DANGER. ACCIDENTAL OPERATION MAY CAUSE FATAL INJURIES.

A safety pin is inserted in the Canopy Jettison Manual Fired Initiator Unit when the aircraft is on the ground, to make the canopy jettison system "safe for parking and servicing". It is stowed by the ground crew before flight, in the front seat right console.

WARNING

FOLLOWING LOSS OR JETTISON OF THE CANOPY, THE AIRCRAFT MUST BE RECOVERED AS QUICKLY AS POSSIBLE TO A MAXIMUM ALTITUDE OF 10 000FT AND TO A SPEED LESS THAN 200KDAS.

The Canopy Jettison System can be initiated by receiving gas signals from the Seat or by mechanical means from operation of the internal or external canopy jettison handles. For initiation from the Seat, each of the duplex gas outputs from the Seat initiates a cartridge within the CJGFIU. For mechanical operation, the input from the internal and external canopy jettison handles interfaces with the CJGFIU, with each input operating both cartridges. Gases from the initiator are routed via gas lines and trombone units to the Canopy Actuator Disconnect Piston Unit (CADPU), and to the Canopy Emergency Unlock Cylinders (CEUCs). The trombone units provide a means of maintaining the gas path from the fuselage to the canopy, whilst the canopy moves from closed to the fully open position. The gases allow the actuator disconnect piston units to release the canopy from the canopy raise/lower actuator. They also initiate the cartridges in the unlock cylinders, which force the cylinders to activate the canopy lock/unlock mechanism, unlocking the canopy.

At the end of the unlock cylinders' strokes, gases are routed to the rocket motors' initiator cartridges. These gases are routed to both rocket motor cartridges to ensure the sequence continues should one cylinder or one motor initiator cartridge fail.

NOTE

Should the canopy fail to jettison during the ejection sequence and the canopy has remained locked, canopy breakers on the head-box of the seat will fracture the transparency as the seat rises, providing an escape path for the ejection seat.

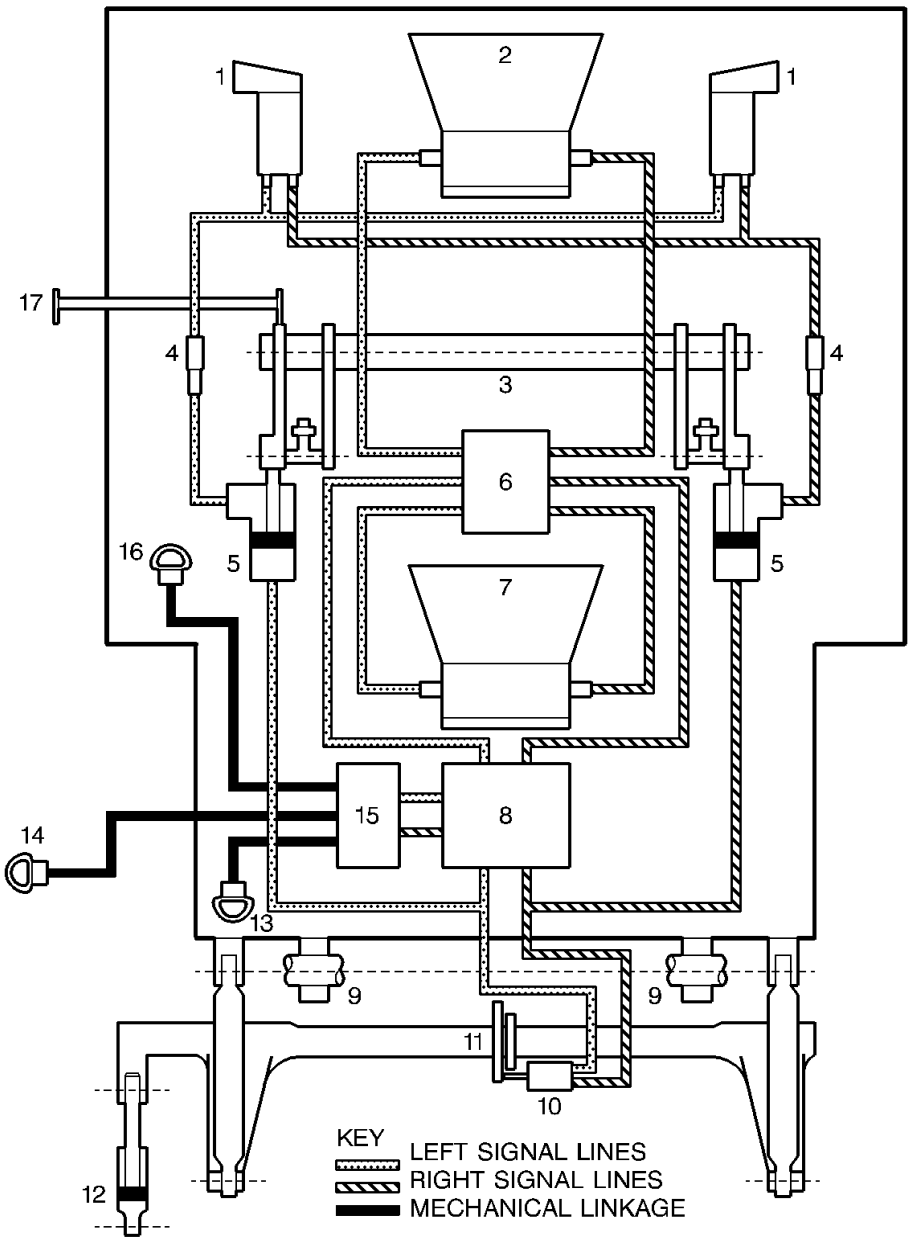
Once ignited, the rocket motors force the canopy upwards, shearing the hinge pin. When the canopy reaches an angle of 65°, the hinge releases to allow the canopy to fly clear of the aircraft.

NOTE

Should the canopy fail to jettison during the ejection sequence and the canopy has remained locked, canopy breakers on the head-box of each seat will fracture the transparency as the seat rises, providing an escape path for the ejection seats.

Jettison of the canopy when it is in a partial or fully open position is possible but successful canopy release cannot always be guarenteed as the CADPU is only capable of releasing the clutch under the conditions expected in-flight and certain ground case

conditions. With the canopy open it is possible that the load in the clutch can be above that which the CADPU is capable of operating against for example, when there is a headwind or taxiing on a rough surface. If this occurs, the trajectory of the jettissoned canopy cannot be predicted reliably as the canopy would not be able to rotate about its hinge freely.



1 CANOPY JETTISON ROCKET MOTOR
2 FRONT EJECTION SEAT
3 CANOPY LOCK/UNLOCK MECHANISM
4 CANOPY JETTISON TROMBONE UNIT
5 CANOPY EMERGENCY UNLOCK CYLINDER
6 COMMAND MODE SELECTOR
7 REAR EJECTION SEAT
8 CANOPY JETTISON GAS FIRED INITIATOR UNIT
9 CANOPY HINGE INCORPORATING SHEAR PIN
10 CANOPY ACTUATION DISCONNECT PISTON UNIT
11 CLUTCH MECHANISM
12 CANOPY ACTUATOR
13 REAR CANOPY JETTISON INTERNAL HANDLE
14 CANOPY JETTISON EXTERNAL HANDLE
15 CANOPY JETTISON MANUAL INITIATOR UNIT
16 FRONT CANOPY JETTISON INTERNAL HANDLE
17 CANOPY LOCK/UNLOCK EXTERNAL HANDLE INTERFACE

Figure 1.143 - Canopy Jettison System Schematic

Canopy Jettison System

(1B-B-95-20-00-00A-111A-A Issue 002)

Introduction

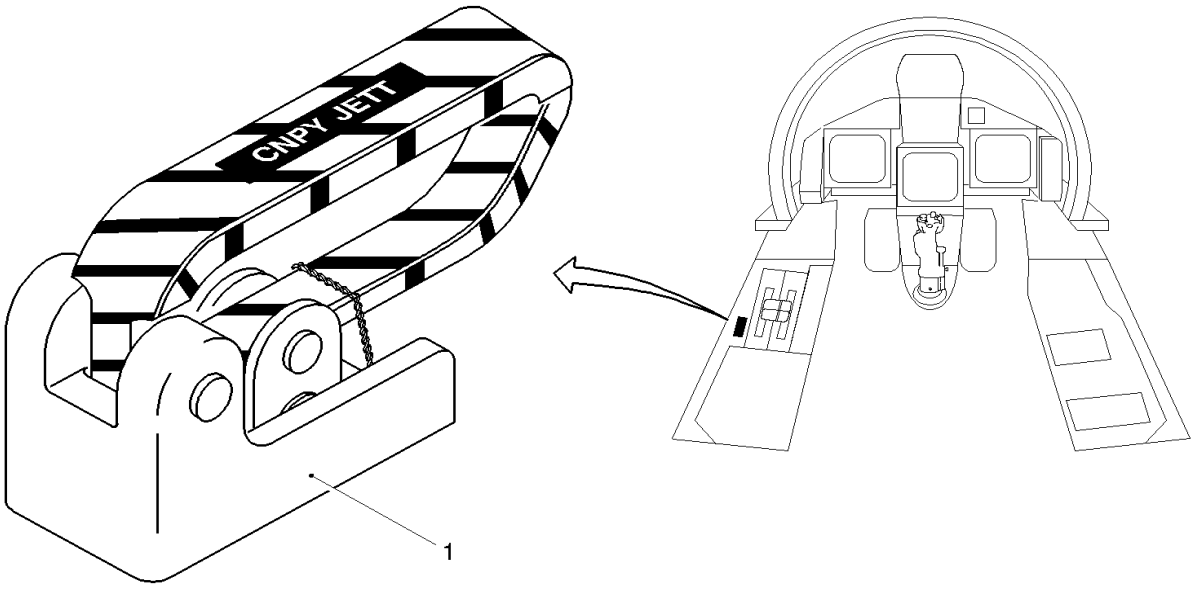
The canopy jettison handles allow manual jettison of the canopy in the event of an emergency. The handles are mounted internally, for use by the aircrew whilst in-flight or on the ground, and externally, for use by the ground crew or emergency services.

Internal Canopy Jettison Handle

The internal canopy jettison handle, located on the left console, is labeled CNPY JETT on a yellow background with black stripes (Figure 1.144) .
The internal canopy jettison handle is located in the same position in both the front and rear cockpits.

External Canopy Jettison Handle

The external canopy jettison handle, located on the side of the left engine air intake, is labeled EMERGENCY RELEASE EXPLOSIVE CANOPY (Figure 1.144). It is a black and yellow striped handle positioned behind a frangible clear perspex panel. The handle is attached to a cord; the length of which affords a safe distance between ground crew and aircraft when fully extended.



1 INTERNAL CANOPY JETTISON HANDLE
2 EXTERNAL CANOPY JETTISON HANDLE

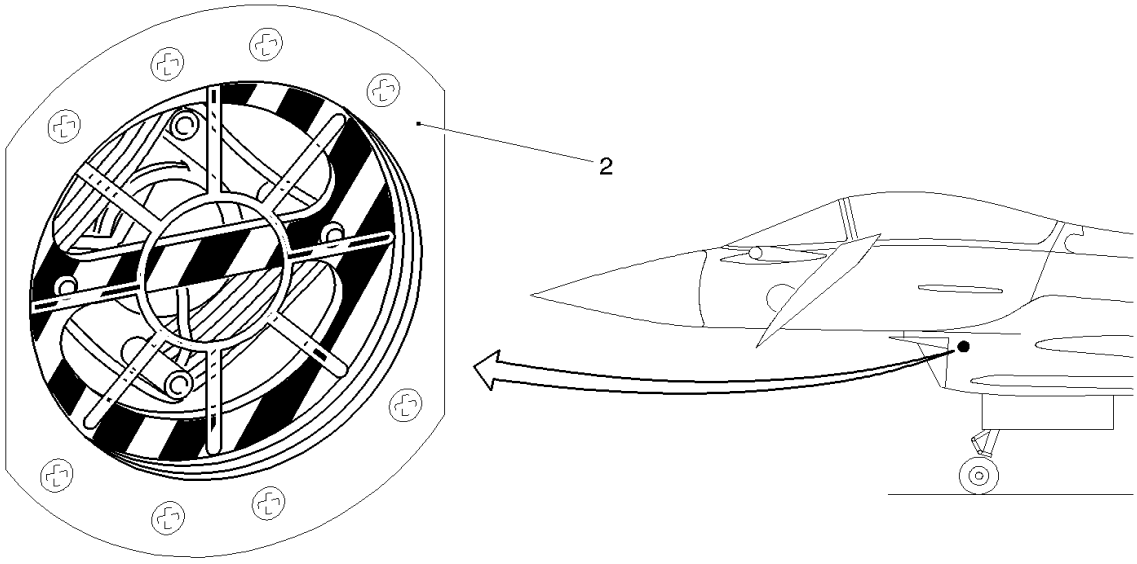


Figure 1.144 - Canopy Jettison Handles

ENVIROMENTAL CONTROL STSTEM

Environmental Control System

(1B-B-21-00-00-00A-043A-A Issue 003)

General

The environmental control system (ECS) uses bleed air from the engines to provide conditioned air and pressurization for the cabin and cooling air for the avionics and general equipment (see Figure 1.145). The ECS also provides precooled air for the following subsystems:

– canopy seal inflation
– transparency antimist/demist
– molecular sieve oxygen generation (MSOG)/ radar pressurization
– anti-g.

Bleed Air System

The bleed air for the ECS is taken from the 5th stage of each engine HP compressor through the engine bleed shut-off valves (EBSOVs). A check valve in each line prevents reverse flow from one engine to the other. The bleed air lines are combined and routed to the precooler via:

– a variable pressure regulator and shut-off valve (VPRSOV) or,
– a molecular sieve oxygen concentrator pressure regulator and shut-off valve (MSOC PRSOV).

The temperature of the precooler bleed air output is regulated by the precooler bypass valve. The precooler is ram air cooled in flight. Below 200 kt in flight or when on the ground, the precooler ejector SOV supplies bleed air to induce coolant flow through the precooler. The position of each SOV and the bypass valve is controlled and monitored by the UCS front computer.

There is a leak detection loop installed between the EBSOVs and the precooler. The leak detection loop is monitored by the UCS front computer. If a hot air leak is detected the UCS front computer closes both EBSOV. If an EBSOV fails to close the corresponding L (or R) ECS LK warning is activated.

On the ground, in alert operation, the air for the ECS is supplied by the secondary power system (SPS).

The bleed air flow rate is controlled by varying the output of the VPRSOV. A venturi in the main ECS pipe limits the maximum flow for any regulator setting.

Air Conditioning System

The precooled bleed air is supplied to the air conditioning system through the environmental control system shut-off valve (ECS SOV).
The precooled air from the ECS SOV passes through the temperature control valve (TCV) into the cold air unit (CAU) compressor. The air is cooled in the intercooler and the regenerative heat exchanger. The turbine inlet water extractor (TIWE) removes most of the free water before the air enters the CAU turbine. The CAU turbine output air temperature is regulated by the position of the TCV.
The ECS SOV and the TCV are controlled and monitored by the UCS front computer. The TCV routes the bleed air to the CAU and/or to the CAU bypass line. The CAU turbine air output passes through the MSOC and liquid/air heat exchanger and into the main water extractor. The main water extractor removes most of the remaining condensed water.
In flight the intercooler is ram air cooled. Below 190 kt in flight or when on the ground, the intercooler ejector SOV supplies bleed air to induce coolant flow through the intercooler. The intercooler ejector SOV is controlled and monitored by the front computer.

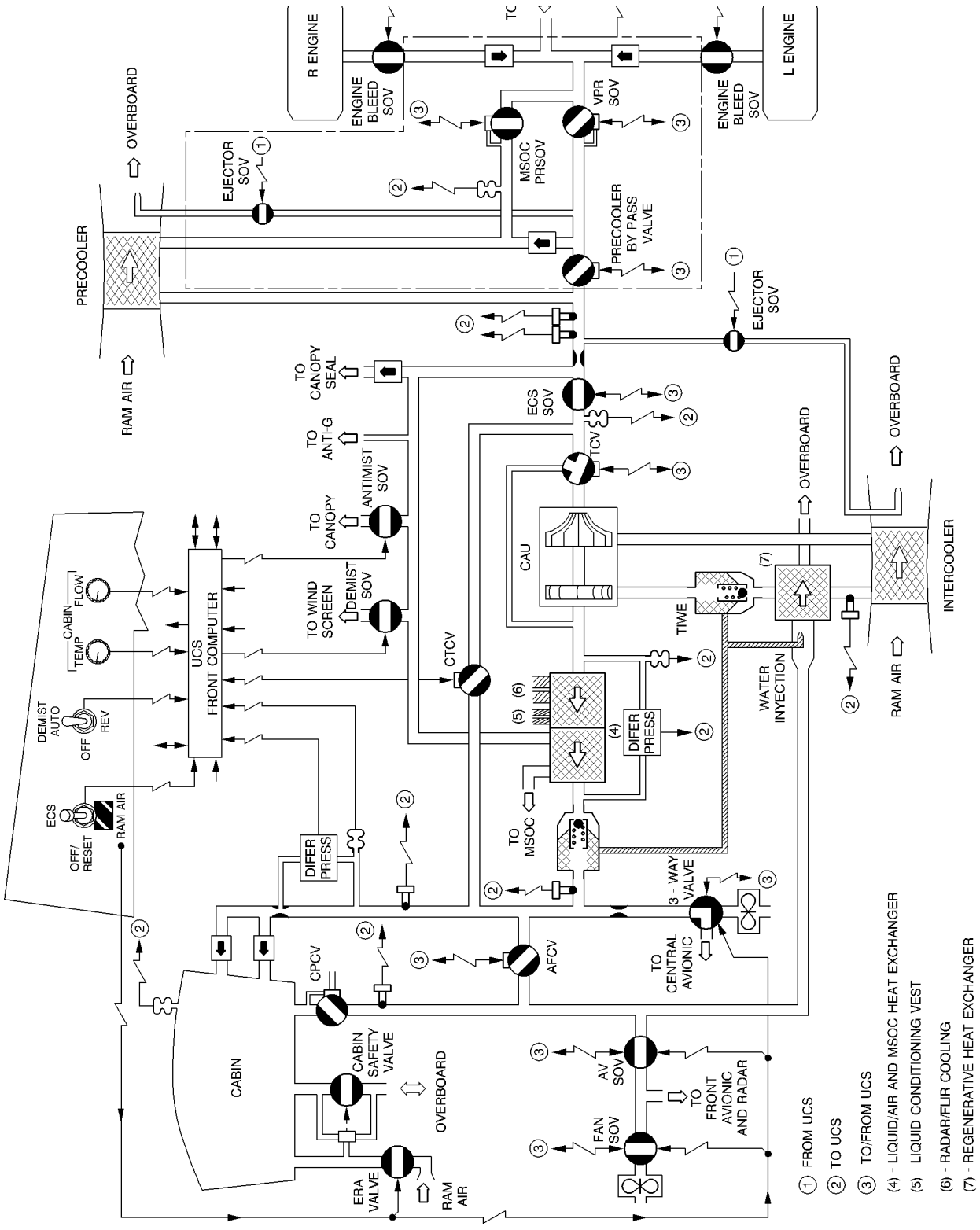


Figure 1.145 - Environmental Control System - Functional Schematic

Environmental Control System

(1B-B-21-00-00-00A-112A-A Issue 003)

Alert Operation

The air is supplied from the SPS. The air is conditioned by the air conditioning system to provide cabin air conditioning and heat sink for the radar/ FLIR cooling and the liquid conditioning vest.
The avionic cooling air is from the front and center cooling fans. The AVSOV is closed and the fan SOV is open. The front cooling fan air is routed to the front avionic and the radar bays. The 3-way valve is "open-to-fan" and routes the center cooling fan air to the center avionic bay.
Service lines supply air to the MSOC/radar pressurization, the canopy seal, the antimist/demist and the anti-g subsystems.
The ejector SOVs are open connecting the bleed air to the ejectors to induce coolant flow through the precooler and the intercooler heat exchangers.

Taxi, Takeoff and Landing

The ECS operation in this mode is as described for the alert operation but the bleed air is supplied from the engines.

Normal Flight

The air is supplied from the engines to the ECS system. The air is conditioned by the air conditioning system to provide:

– cabin air conditioning
– front avionic and radar bays cooling
– center avionic bay cooling
– heat sink for the radar/FLIR cooling and the liquid conditioning vest.

The AVSOV is open, the fan SOV is closed, the 3-way valve is "open-to-ECS" and, the front and center cooling fans are off.
The service lines supply air to the MSOC and radar pressurization, the canopy seal, the antimist/demist and the anti-g subsystems.
The ejectors SOV are opened or closed depending of aircraft altitude, bleed temperature and airspeed.

ECS Failure in Flight

In case of ECS failure (with the exception of a hot air leak) the VPRSOV and the ECS SOV will close and the MSOC PRSOV will open. The engine bleed air is routed through the MSOC PRSOV and the precooler to the MSOC service line to provide breathing gas to the pilot.
The service lines supply air to the anti-g and canopy seal subsystems.
The antimist/demist SOVs are closed and, the subsystem is inhibited to save the air for the MSOC.
The heat sink for the radar/FLIR cooling and the liquid conditioning vest is lost.
The cabin air conditioning and cockpit avionic cooling are with ram air through pilot selection of the ECS switch to RAM AIR. The flight is limited to the emergency ram air envelope.
The avionic cooling air is from the front and center cooling fans, as described in "alert operation".

Flight in Transient Conditions

If an engine fails during normal flight, bleed air is taken from the "live" engine and ducted to run the gearbox of the non-operating engine via the SPS. Air is also supplied to ECS, except in case of ECS and SPS requirements are incompatible. During the cases were the "live" engine can not supply sufficient air for ECS and SPS, the ECS controlling software instructs the VPRSOV and the ECS SOV to close and the MSOC pressure regulator to open, to maintain the supply of breathing gas to the pilot.
If the situation described above is maintained for a short period of time (2 minutes), after which, the normal ECS operation is not recovered, the ECS warning is generated, and the ECS goes into the functional situation described in "ECS failure in flight".

ECS Failure in Flight Caused by Hot Air Leakage

In case of a hot air leakage the EBSOV of each engine is closed automatically by the UCS. There is no bleed air.
The cabin air conditioning and the avionic cooling is as described in "ECS failure in flight".
There is no air available through the services lines to any subsystem, including the MSOC supply.

Canopy and Windscreen Sealing

(1B-B-21-32-00-00A-043A-A Issue 002)

Canopy Sealing

A continuous inflatable rubber seal is installed along the canopy edge members and arches, to form an airtight seal between the canopy and the windscreen arch, and the canopy and the aircraft structure. This allows the cabin pressure to be maintained.
The seal is inflated by precooled air supplied from the ECS through a nonreturn valve, a pressure reducing/relief valve and an inflation/deflation valve.
A lever, on the canopy torque tube behind the ejection seat, opens/closes the inflation/deflation valve to actuate the supply of air to the seal when the

canopy is locked/unlocked. When the aircraft is on the ground and the ECS is not operating, a reservoir bottle will supply the air for canopy seal inflation.

The reservoir bottle can be pressurized to supply air to inflate the canopy seal by the ECS or alternatively by the charge connection on the ground (located in the nose undercarriage bay). Adjacent to the charge connection is a gage which provides an indication of the seal system pressure.

Once the system is pressurized the seal will remain adequately inflated without further charging for up to 48 hours.

Windscreen Sealing

The windscreen/sill interface utiliizes a static seal, which improves its capability as the pressure between the cabin and outside varies.

Cabin Air Suppy System

(1B-B-21-21-00-00A-043A-A Issue 002)

The cabin air supply system receives conditioned air from the air conditioning system. The air is distributed to the cabin by means of a distributed set of ducts and vents.

The airflow supplied is controlled by the front computer via the utilities control system (UCS). This receives signals from different sensors and from the pilot requirements by means of the cabin airflow control.

The UCS acts on the airflow control valve (AFCV) to regulate the airflow which enters the cabin.

The pilot selects the airflow with the cabin airflow control. The UCS evaluates the difference between the current flow and the new selected flow and commands the AFCV to open or close to achieve the requested cockpit flow demand.

The temperature of the cabin mass air flow is controlled by the cabin temperature control valve (CTCV) in the air conditioning system bypass line. The CTCV controls the amount of hot air that is mixed with the cold air coming from the MSOC and liquid/air heat exchanger.

The pilot can change the temperature with the cabin temperature control. The front computer monitors the cabin inlet and outlet temperature to command the CTCV to open or close. Thus giving the requested temperature by varying the position of the CTCV.

When the ECS SOV is closed, due to an ECS failure, the pilot must open the ERA valve to ventilate the cabin. The ERA valve is opened when the ECS switch is set to RAM AIR. When the ERA valve opens, it pneumatically opens the cabin safety valve (CSV). The cabin is ventilated by ram air and is unpressurized.

Pressurization System

(1B-B-21-30-00-00A-043A-A Issue 003)

The pressurization system provides pressure control for the cabin. The cabin pressurization is obtained by controlling the overflow of conditioned air from the cabin through the cabin pressure control valve (CPCV). The control of the pressure schedule by the CPCV is automatic.

In the case of CPCV failure or if the cabin pressure goes to sub-atmospheric condition, the cabin safety valve (CSV) prevents the cabin differential pressure from exceeding the maximum established limits. The CSV can inward relief and outward relief. The CSV opens to inward relief for a low differential pressure and to outboard relief for excessive differential pressure.

The UCS generates the cabin low pressure (CABIN LP) or the cabin high pressure (CABIN HP) warning via the dedicated warning panel to indicate system malfunction to the pilot.

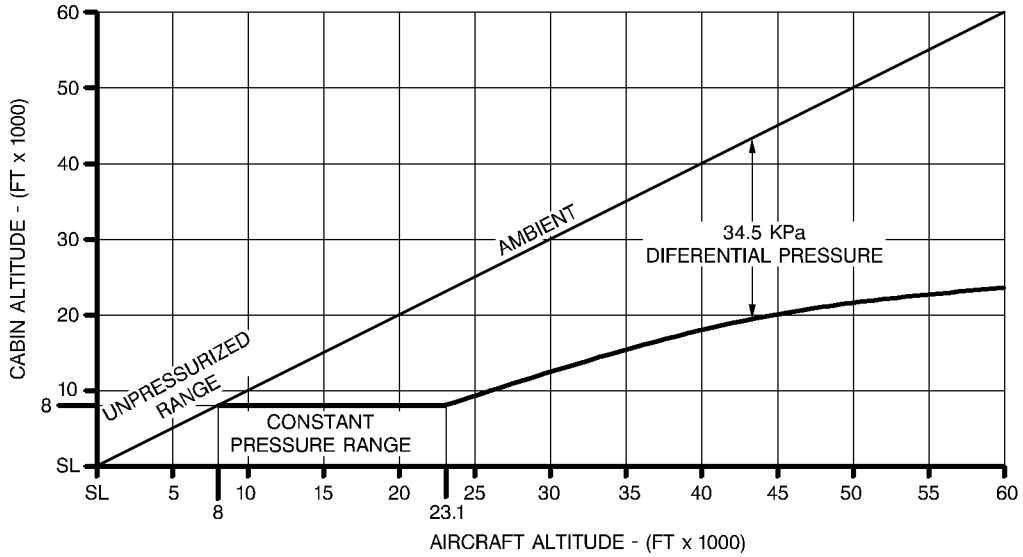


Figure 1.146 - Cabin Pressure Schedule

Avionic Air Supply System

(1B-B-21-22-00-00A-043A-A Issue 002)

The avionic air supply system cools the equipment installed in the center avionic, the front avionic and the radar bays. This equipment are cooled with air from the air conditioning system or, on the ground and for a emergency operation with air from two cooling fans.

During normal flight operation, with the ECS switch at ECS:

- The avionic shut-off valve (AVSOV) routes cooling air to the front avionic and the radar bays. The 3-way valve routes cooling air to the center avionic bay. The fan SOV is closed and the two cooling fans are off.
- The center avionic bay is cooled by cooling air from the cold air unit (CAU).
- The front avionic and the radar bays are cooled by a mixture of cabin air and cooling air from the CAU.

During ground operation with the ECS switch at ECS or RAM AIR:

- the AVSOV closes
- the fan SOV opens and switches on the front cooling fan
- the 3-way valve changes over and switches on the center cooling fan
- the two cooling fans provide the cooling air for the avionic and general equipment.

In flight, when a component malfuntion or failures are detected the pilot must selects the emergency operation cooling mode by positioning the ECS switch to RAM AIR. If the pilot selects ram air in flight the AVSOV, the fan SOV and the 3-way valve are positioned as in the ground case, and the two cooling fans are switched on. If any fan fails to operate the UCS generates the FAN warning via the dedicated warning panel.

If the aircraft is on ground, the air speed is below 100 Kt, or both engines rpm are below 60 % then the control software of the UCS changes the three-way valve position, closes the AVSOV, opens the fan SOV and switches on the two cooling fans. In this case the equipment is cooled by external air supplied from the fans.

There is a warning horn to alert the ground crew if any fan is not running when the aircraft is electrically powered.

Avionic Liquid Cooling System

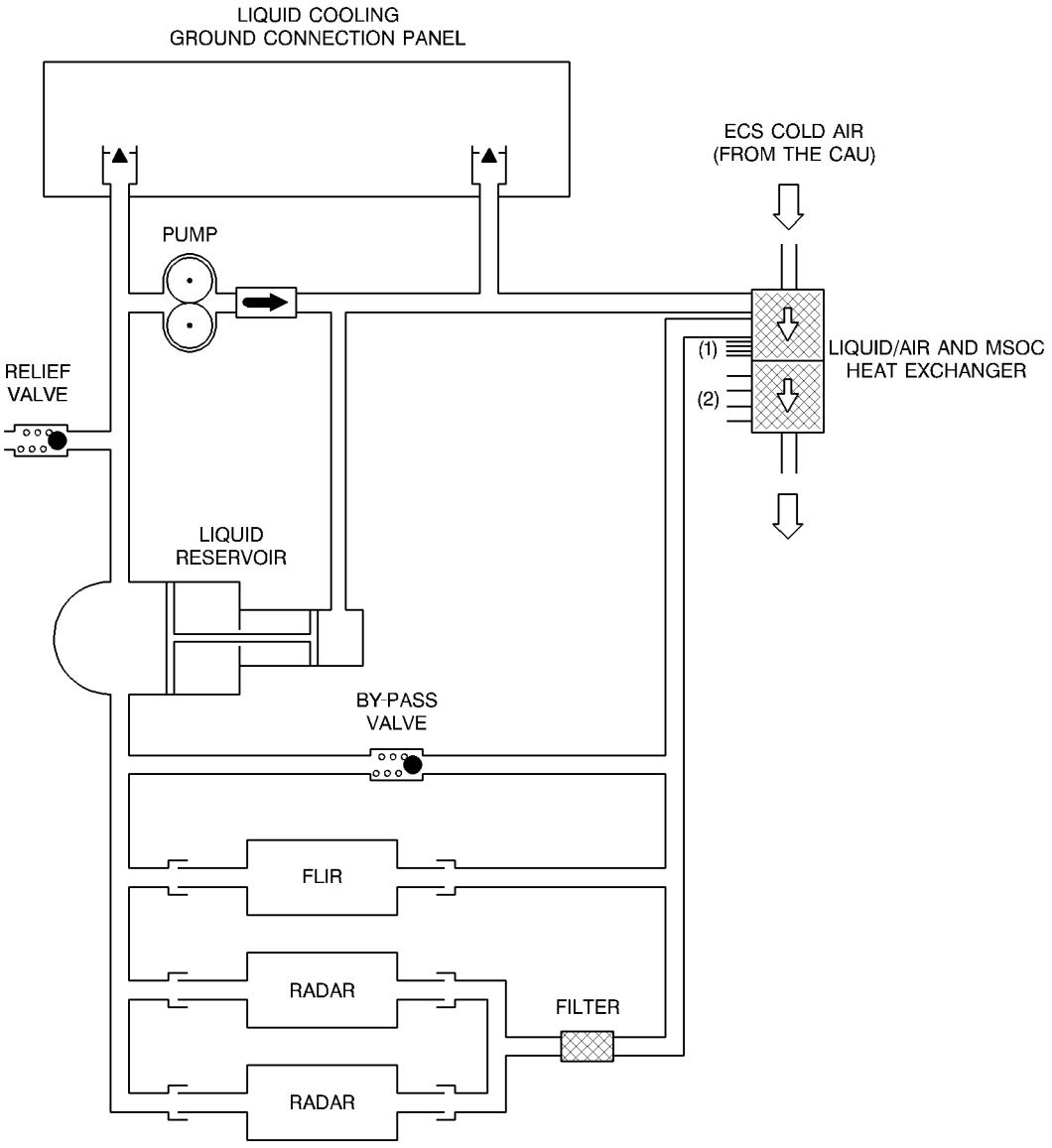
(1B-B-21-80-00-00A-043A-A Issue 002)

The avionic liquid cooling system is a closed circuit which removes the heat generated by the Radar and FLIR unit and dissipates it to the conditioned air supply via the liquid/air and MSOC heat exchanger (see Figure 1.147).

A pump, controlled by the UCS front computer, is used to circulate the coolant liquid around the circuit. From the pump outlet, the liquid passes through the liquid/air and MSOC heat exchanger and then through the Radar/FLIR. After cooling the Radar/ FLIR it passes through the liquid reservoir before reaching the pump inlet. The reservoir controls the coolant pressure at pump inlet and accommodates expansion of the liquid.

If a blockage occurs within the radar and the Radar/ FLIR inlet pressure rises above a preset level, the liquid by-pass valve opens. A second liquid relief valve is positioned upstream of the pump. This will dump excess coolant liquid overboard, protecting against overfilling when using the ground trolley or a failure of the reservoir expansion mechanism.

There are ground connections at either side of the pump for cooling the Radar/FLIR at ground without engines or SPS running. A microswitch in the ground connection causes the aircraft pump to be electrically isolated when the ground cooling trolley is connected. The ground connections are also used to refilling the system.



(1) LIQUID CONDITIONING VEST

(2) SUPPLY AIR TO THE MSOC SYSTEM

Figure 1.147 - Avionic Liquid Cooling System - Functional Schematic

Antimist/Demist System

(1B-B-21-24-00-00A-043A-A Issue 002)

General

The windscreen demist facility and the canopy antimist facility are by a pneumatic antimist/demist system, and the windscreen antimist is by an electrical antimist system.

Pneumatic Antimist/Demist System

The antimist/demist system receives precooled bleed air from the ECS system, then delivers it to the canopy and windscreen. The precooled bleed air is divided into two lines, one line supplies air to the canopy antimist facility and the other line supplies air to the windscreen demist facility.

The antimist flow passes through the antimist SOV to supply air to the canopy transparency. When selected, flow is controlled automatically to maintain the inner surface of the canopy at a temperature above the dew point temperature, and so prevents the formation of condensation.

The demist facility, which has to be selected, provides a means of demisting the windscreen in the case of failure of the electrical antimist system. The demist flow passes through the demist SOV. With the demist SOV open, a large quantity of air flows over the windscreen surfaces.

The pneumatic antimist/demist system is controlled by the demist switch located on the right console.

Electrical Antimist System

The windscreen antimist is by means of electrically heated elements controlled by a control unit. The control unit controls the application of electrical power to the windscreen heating elements and automatically maintains the windscreen temperature at a required level to prevents mist formation in flight. The temperature is monitored by three sensors, when these sensors detect different temperatures the highest value is used. The system is activated by the windscreen heater switch located on the systems gangbar at the rear of the right console.

Windscreen Heater Switch

A two position toggle switch, located on the right console (inside the systems gangbar) and labeled W/S HTR - OFF, controls the operation of the windscreen heating system. When the switch is in the W/S HTR position, the windscreen heating elements are energized under control of the windscreen control unit. The windscreen heating is deenergized when the demist switch is set to REV.

Windscreen Warning

On the dedicated warning panel, the following caption is presented:

WINDSCRN (CAT 3 - amber) Indicates a failure of the windscreen heating system.

The WINDSCRN caption is accompanied by attention getters and the "windscreen heater fail" voice warning message.

Emergency Ram Air

(1B-B-21-31-00-00A-043A-A Issue 002)

The emergency ram air (ERA) system provides ram air for the cabin conditioning and avionics cooling in the case of an ECS failure.

By positioning the ECS switch in the RAM AIR position the ERA valve and the cabin safety valve, which are pneumatically linked, are opened. The airflow comes into the cabin through a ram air scoop mounted on the left side of the aircraft skin. Additionally, the avionics SOV is closed, the fan SOV is opened and the three-way valve is positioned to permit the airflow from the fan to the center avionic bay. The fans are switched on, consequently the center avionic bay and the front avionic and the radar bays are conditioned by air from the fans.

The flight is limited to the emergency ram air envelope. The ERA envelope is defined by speed and altitude, to contain ram temperatures within limits. The ERA envelope can be displayed on the right MHDD by selecting the ERA PROF key.

Ice Detection

(1B-B-30-80-00-00A-043A-A Issue 002)

The ice detection system initiates the ICE warning (CAT 3) via the DWP when icing conditions are encountered and an ice accretion has occurred on the ice detector sensing probe.

ICE Warning

On the DWP, the following caption is presented:

ICE (CAT 3 - amber) Indicates that icing conditions have been encountered in the engines air intakes.

The DWP caption is accompanied by attention getters and the "icing" voice warning message.

Environmental Control System

(1B-B-21-00-00-00A-111A-A Issue 003)

General

The controls of the environmental control system are located on right quarter panel and right console (see Figure 1.148).

ECS Switch

A three position toggle switch labeled ECS - OFF/ RESET - RAM AIR, controls the operation modes of the ECS as follows:

ECS The ECS operates normally under UCS software control.

OFF/RESET The ECS does not operate. The UCS software of the ECS is reset. In this position the following functions of the ECS are retained:

– The anti-g supply
– The canopy seal supply
– The MSOG supply.

RAM AIR The normal operation of the ECS is disabled. The cabin is depressurized. The ERA valve is opened to supply air to the cabin. In addition, the front and center avionic fans supply cooling air to the avionic equipment. In this position the following functions of the ECS are retained:

– The anti-g supply
– The canopy seal supply
– The MSOG supply.

The switch is locked in the centre (OFF/RESET) and aft (RAM AIR) positions, and must be unlocked prior to selection of the aft or forward positions respectively.

Demist Switch

A three position toggle switch labeled DEMIST AUTO - OFF - REV, controls the antimist/demist as follows:

AUTO Normal selection. The canopy antimist facility operates normally under software control to prevent transparency misting. A flow of partially conditioned engine bleed air is supplied over the inside of the canopy via the antimist SOV. This function is unavailable if the ECS switch is not selected to the ECS position.

OFF No antimist/demist. The antimist SOV is closed.

REV A continual (reversionary) flow of partially conditioned engine bleed air is supplied over the inside of the canopy and windscreen via the demist SOV and antimist SOV. The windscreen heater is de-energized.

Cabin Temperature Control

A circular rotary control labeled CABIN TEMP controls the air temperature of the cabin. Clockwise rotation increases the selected temperature of air flowing into the cabin, via the ECS vents. Anticlockwise rotation decreases this temperature level.

Cabin Airflow Control

A circular rotary control labeled CABIN FLOW controls the volumetric rate of airflow into the cabin. Clockwise rotation increases the selected volumetric rate of air flowing into the cabin, via the ECS vents. Anticlockwise rotation decreases this flow rate level.

Locality Specific Protection Switch

The locality Specific protection is a two position toggle switch labeled ECS NORM and LSP. When placed to ECS NORM the ECS operates normally under UCS software control. When placed to LSP and while the aircraft is on ground or aircraft elevation below 131 ft of radio altimeter, the operation is modified as follow:

– conditioned air is not provided to the cabin
– antimist/demist is inhibited
– heat sink for radar/FLIR and liquid conditioning vest is lost
– avionic cooling air is from the front and center cooling fans.

Suit Temperature Control

A circular rotary control labeled SUIT TEMP/OFF controls the temperature of the liquid conditioning vest. Clockwise rotation increases the selected temperature and anticlockwise rotation decreases this temperature level.

ECS Warnings

Information of ECS failures are displayed on the dedicated warning panel (DWP). The following captions are presented:

ECS (CAT 3 - amber) Indicates the loss of cabin and avionic conditioning with engine bleed air. This warning is also generated when:

– the fans are operating when not required, or
– the fans are operating when the aircraft is outside the ERA envelope, or
– the ECS switch is in the off position when the aircraft is electrically powered.

If the warning is due to a hot leak, which has been isolated by the UCS closing the engine bleed SOVs, there is no air supply to either subsystems. If the warning is not caused by a hot leak, the air supply to the MSOG, anti-g and canopy seal subsystems remains.

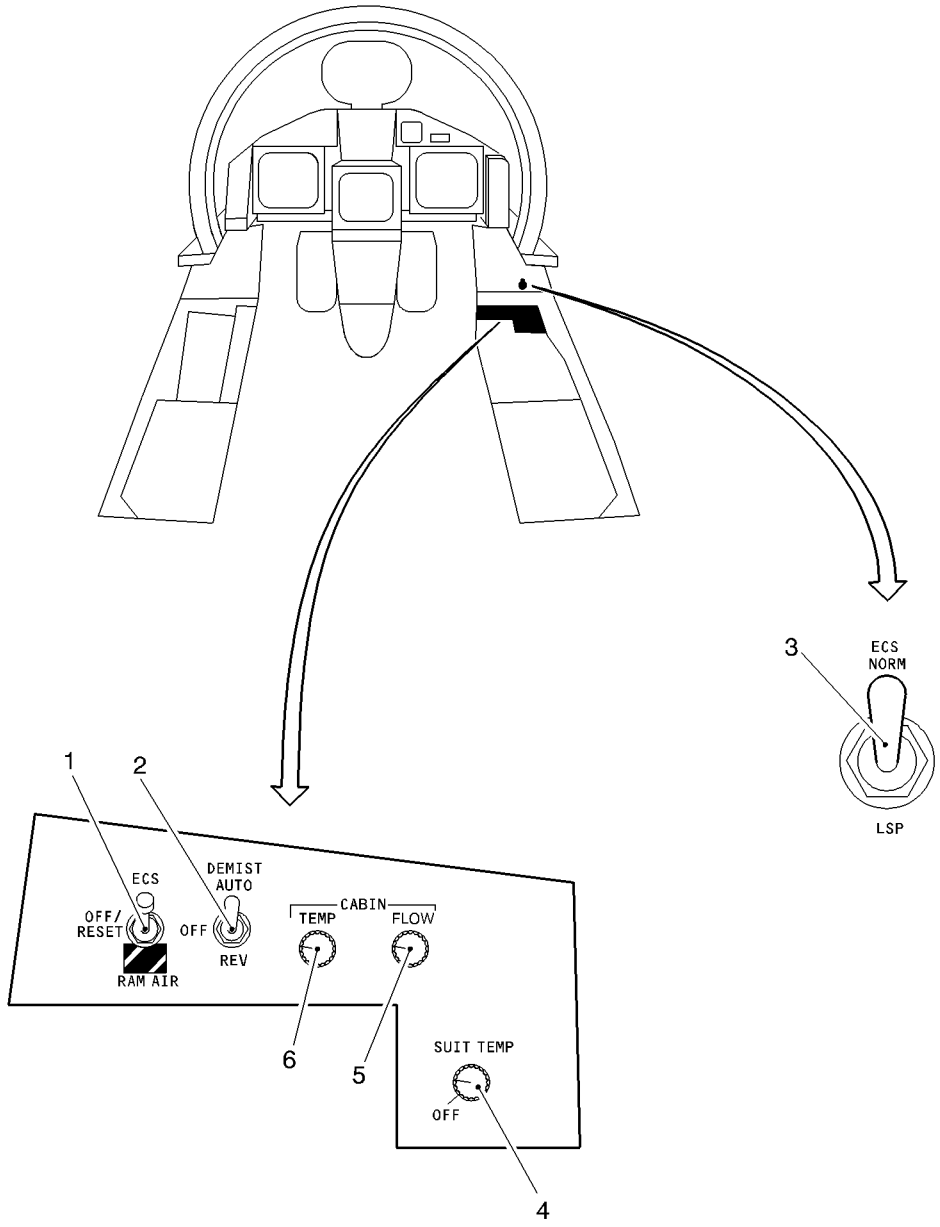
The ECS caption is accompanied by attention getters and the "ECS" voice warning message.

FAN (CAT 2 - red) Indicates a loss of reversionary/ ground conditioning to the avionics. Any of the avionic cooling fans are inoperative whenever required to function. The FAN caption is accompanied by attention getters and "ECS fan" voice warning message.

L (or R) ECS LK (CAT 2 - red) Indicates a hot air leak in the rear fuselage "V" bay together with a failure to close the corresponding engine bleed SOV. The captions are accompanied by attention getters and the "left ECS leak" or "right ECS leak" voice warning messages.

CABIN LP (CAT 3 - amber) Indicates a cabin pressurization failure. The cabin pressure altitude is above 26 000 feet. The caption is accompanied by attention getters and the "cabin low pressure" voice warning message.

CABIN HP (CAT 3 - amber) Indicates that the cabin differential pressure is higher than 45 KPa, due to failures of the CPCV and the cabin safety valve. The caption is accompanied by attention getters and the "cabin high pressure" voice warning message.



1 ECS SWITCH
2 DEMIST SWITCH
3 LOCALITY SPECIFIC PROTECTION SWITCH
4 SUIT TEMPERATURE CONTROL
5 CABIN AIRFLOW CONTROL
6 CABIN TEMPERATURE CONTROL

Figure 1.148 - Environmental Control System - Controls

OXIGEN SYSTEM

Oxygen System

(1B-B-35-00-00-00A-043A-A Issue 005)

The oxygen system consists of two subsystems:

– The molecular sieve oxygen generation (MSOG)
– The auxiliary oxygen.

The MSOG subsystem takes air from the ECS and produces breathing gas at the required oxygen concentration and flow rate. The auxiliary oxygen subsystem provides an auxiliary supply of 100% oxygen.

For the schematic oxygen system see Figure 1.149.

The MSOG gas is routed to a pneumatic changeover valve located within the aircrew service package (ASP), mounted on the left hand side of the seat pan. Then the gas is routed to the mask and chest counter-pressure garment, through a breathing oxygen regulator unit and a personal equipment connector (both in the ASP). The auxiliary oxygen is also routed to the changeover valve. The changeover valve is normally biased to the MSOG supply but when the auxiliary oxygen is selected, due of its higher delivery pressure, this valve is biased to provide 100% oxygen to the breathing oxygen regulator.

Within the auxiliary oxygen bottle head there is a valve for selection of the auxiliary oxygen supply. The utility control system (UCS) selects/deselects the auxiliary supply automatically as required as an auxiliary back-up to the MSOG. An aneroid, set to operate at 25 000 ft, selects the auxiliary oxygen supply in the event of a cabin decompression with or without a UCS failure (for altitudes between 25 000 and 35 000 ft, the UCS can override the aneroid selection if the MSOG is serviceable).

The breathing oxygen regulator unit is a duplex demand type regulator:

– The main regulator delivers breathing gas at a nominal safety pressure (0.375 kPa) at all times.
– The reversionary regulator delivers breathing gas at twice the pressure of the main regulator (0.75 kPa) at all times.

The oxygen regulator selector on the upper face of the regulator assembly enables the pilot to select which regulator is coupled to the system.

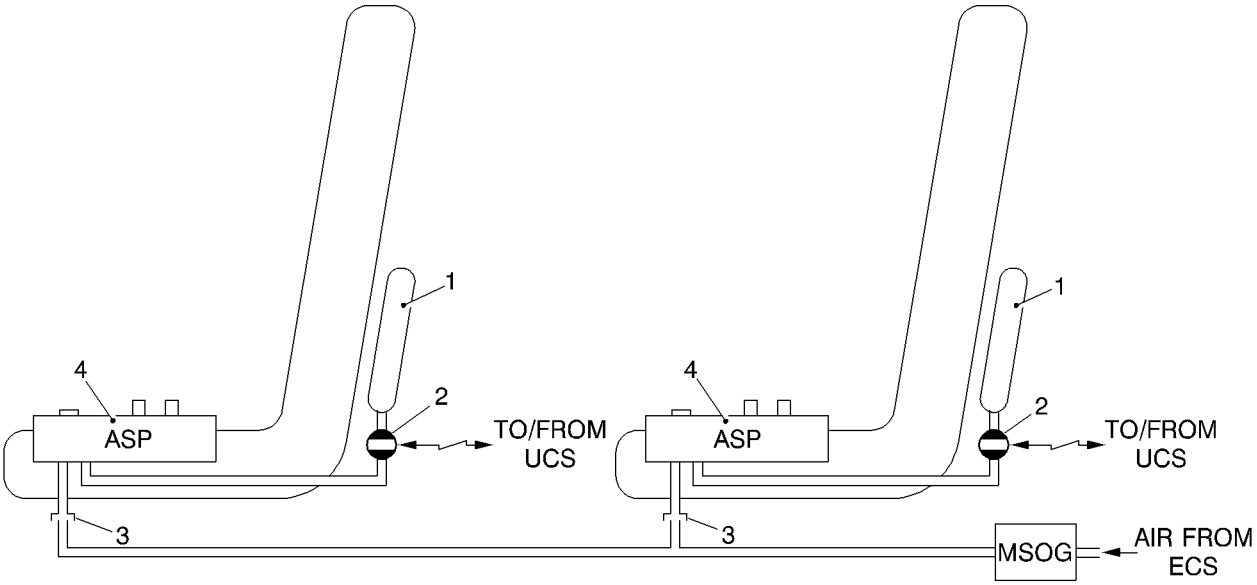
A g-suit pressure signal is supplied to each regulator in order to provide the pilot with pressure breathing under g to increase relaxed g tolerance.

To allow the ejection seat to leave the aircraft unhindered, a quick release coupling is fitted between the MSOG and the ASP.

Oxygen Regulator Selector

A two-position control (Figure 1.150), labeled MAIN - REV, controls the selection of the oxygen regulator coupled to the oxygen supply system as follows:

MAIN	The main regulator is selected. On demand, breathing gas is supplied at a pressure of 0.375 kPa.
REV	The reversionary regulator is selected. On demand, breathing gas is supplied at a pressure of 0.75 kPa.



1 AUXILIARY OXYGEN BOTTLE (AOB)
2 AUXILIARY OXYGEN BOTTLE HEAD
3 QUICK DISCONNECT
4 AIRCREW SERVICE PACKAGE (ASP)

Figure 1.149 - Oxygen System - Schematic (Twin Seat)

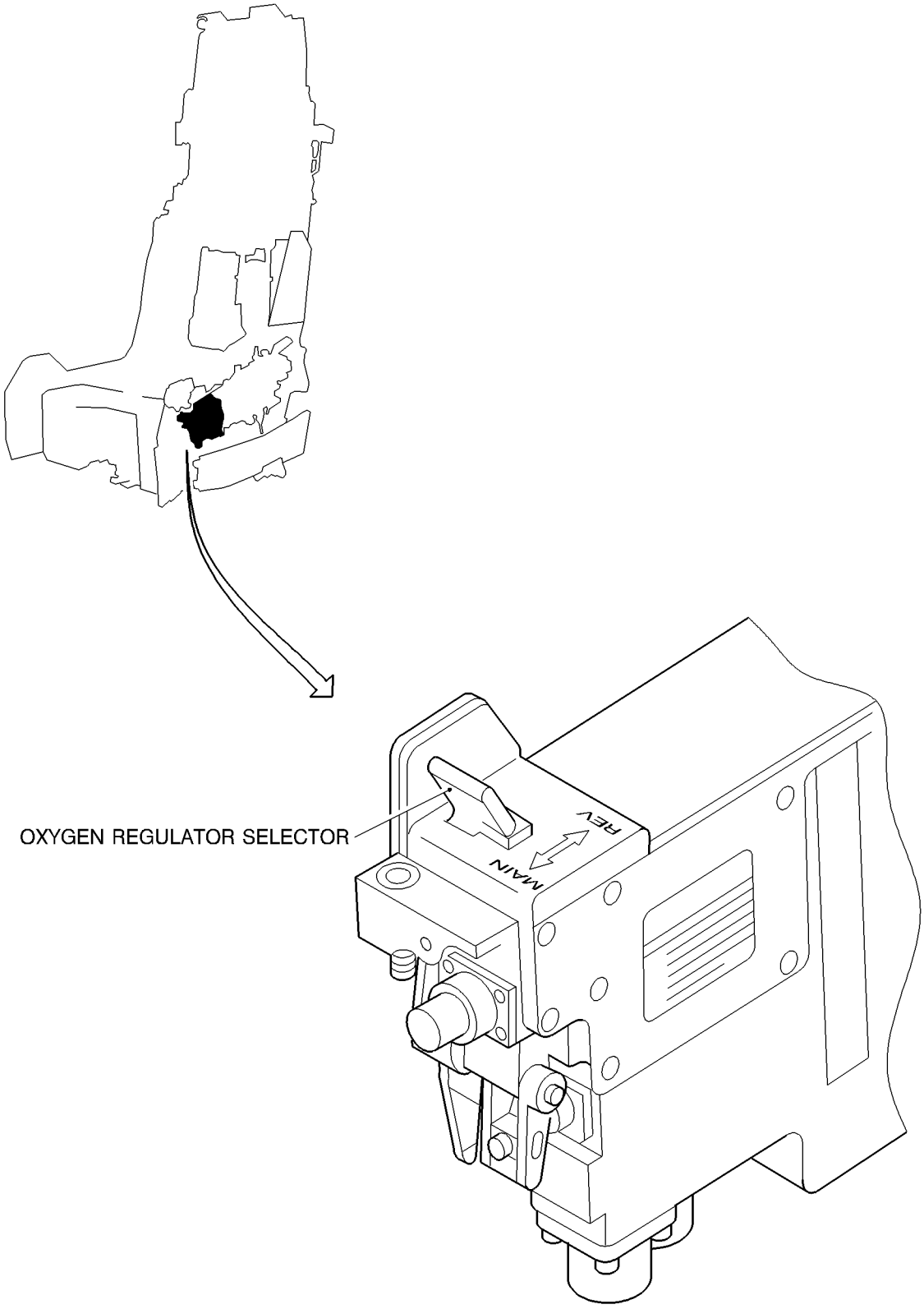


Figure 1.150 - Oxygen Regulator Selector

Molecular Sieve Oxygen Generation

(1B-B-35-40-00-00A-043A-A Issue 005)

The MSOG system provides the main source of breathing gas for the pilot at the required oxygen concentration and flow rate. The MSOG system takes air from the environmental control system (ECS) and responds to the cabin altitude to produce breathing gas of the correct oxygen concentration for that cabin altitude (see Figure 1.151).

The air from the ECS passes through a water separator to reduce the water content to a suitable level. Then the air passes to the molecular sieve oxygen concentrator (MSOC), where an appropriate amount of nitrogen is removed to provide breathing gas of a suitable oxygen concentration. The MSOC also reduces engine bleed air contaminants to an acceptable level.

The MSOC is regulated to produce the appropriate oxygen concentration, by means of a closed loop control process, involving a zirconia oxygen monitor (ZOM) and the UCS front computer. The ZOM produces a signal of oxygen partial pressure by comparing a sample of the breathing gas with the ECS air (reference air). The UCS receives the partial pressure signal from the oxygen monitors and, controls the cycle time of the MSOC to produce breathing gas at the correct oxygen concentration.

The MSOC gas passes through an outlet filter to the aircrew service package. The outlet filter acts as a constraint on particulate matter emanating from the MSOC.

A paramagnetic oxygen monitor (POM) measures the oxygen partial pressure and provides a signal proportional to the oxygen concentration of the breathing gas. The UCS produces a warning signal when either the ZOM or the POM detect that the oxygen partial pressure has fallen below warning limits and selects the auxiliary oxygen supply.

The UCS senses the position of the AOB head valves and:

– when any AOB head valve has moved to the auxiliary oxygen supply position, produces the MSOC warning, and/or
– if any (or both) AOB head valve has (have) not moved to the auxiliary oxygen supply position, produces the OXY warning.

MSOG Warning

On the DWP, the following caption is presented:

MSOC (CAT 3 - amber) Indicates that the breathing gas supply is not provided by the MSOG system. The oxygen supply is from the auxiliary oxygen bottle.

The MSOC caption is accompanied by attention getters and the "MSOC off" voice warning message.

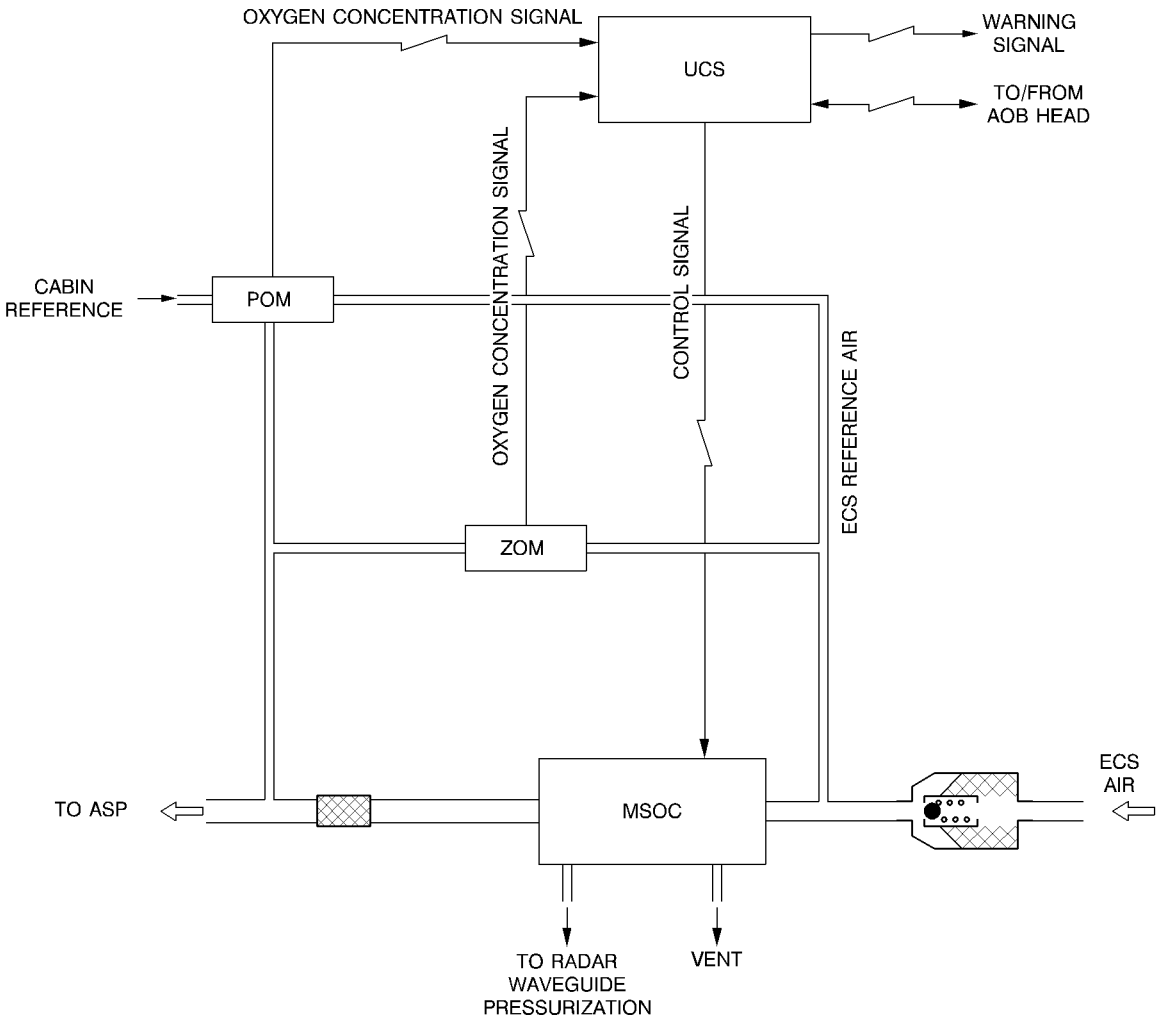


Figure 1.151 - MSOG System - Functional Schematic

Auxiliary Oxygen System

(1B-B-35-12-00-00A-043A-A Issue 004)

The auxiliary oxygen supply is provided by a 200 liters gaseous oxygen bottle mounted on the back of the seat (70 liters are allocated as emergency on ejection).

The auxiliary oxygen supply is activated by opening a valve on the bottle head :

- automatically on ejection
- manually by pulling the auxiliary oxygen selector handle located on the left side of the seat pan
- automatically by UCS, when there is a failure in the MSOG system
- automatically by aneroid, when the cabin altitude is above 25 000 ft.

When there is not a UCS or an aneroid selection, the manual selection of auxiliary oxygen supply can be manually deselected. The UCS selection of the auxiliary oxygen supply is inhibited when the aircraft is on the ground.

The selection of the reversionary regulator is automatic when the auxiliary oxygen supply is manually selected or upon ejection selection.

Pressure and temperature sensors fitted to the auxiliary oxygen bottle (AOB) enable the UCS to calculate the contents of the bottle. This indication is displayed in cockpit via the multi-function head down display (MHDD), only when the bottle is in use.

The bottle may be recharged in situ. The charging point is located on the head of the bottle.

Auxiliary Oxygen Selector Handle

A black and yellow striped handle (Figure 1.152) located on the left side of the seat pan, allows to select the auxiliary oxygen supply in the case of MSOG system failure.

Oxygen Warning

The UCS generates the OXY (CAT 2 in NAV and COMB, CAT 3 in GND, TAKEOFF and APP/LDG) warning when:

- auxiliary oxygen supply is selected (UCS or manual) and the UCS does not detect that the AOB head valve has moved to the auxiliary oxygen supply position
- a failure of AOB head valve position monitor
- the AOB contents is at or below 70 liters
- auxiliary oxygen supply is selected and AOB contents unknown (therefore assumed empty).

The OXY caption is accompanied by attention getters and the "oxygen" voice warning message.

NOTE

If the reversionary GUH mode is selected, the OXY warning is CAT 2 in all POF.

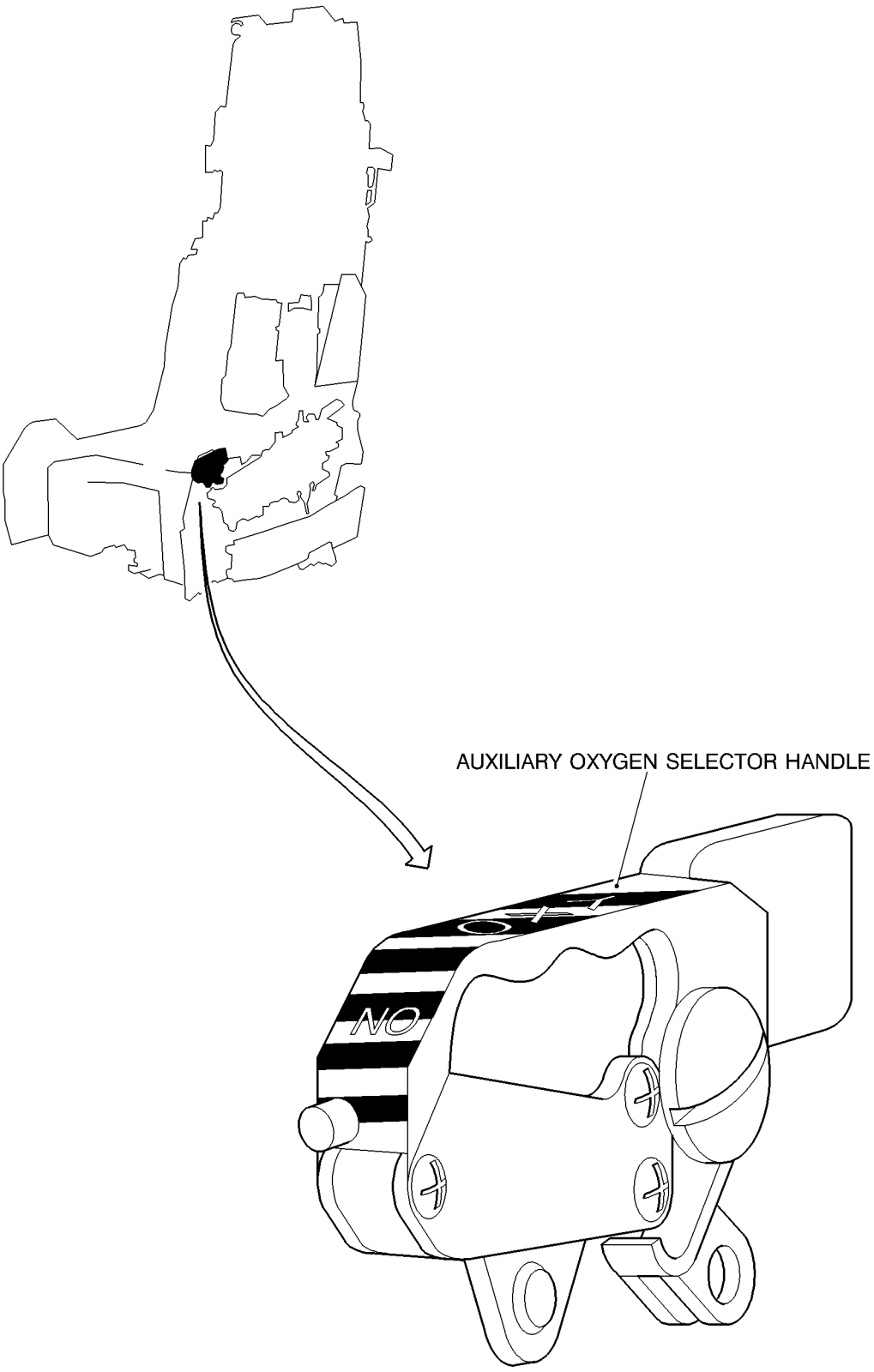


Figure 1.152 - Auxiliary Oxygen Selector Handle

Anti-G System

(1B-B-35-11-00-00A-043A-A Issue 003)

The anti-G system takes precooled air from the ECS and inflates and pressurizes the anti-G full coverage trousers, to provide protection against the G-effects. The anti-G system consists of an anti-G valve mounted within the aircrew service package, on the left side of the seat pan. The anti-G valve opens at a loading in excess of 2G to permit anti-G full coverage trousers inflation. The G-trousers pressure varies linearly with G.

The G-valve outlet pressure is also connected to the breathing gas regulator. The regulator then provides positive pressure breathing with G. The regulator, in response to the G pressure, provides elevated mask tube and chest counter pressure bladder (CCPB) pressure proportional to the G-trousers pressure.

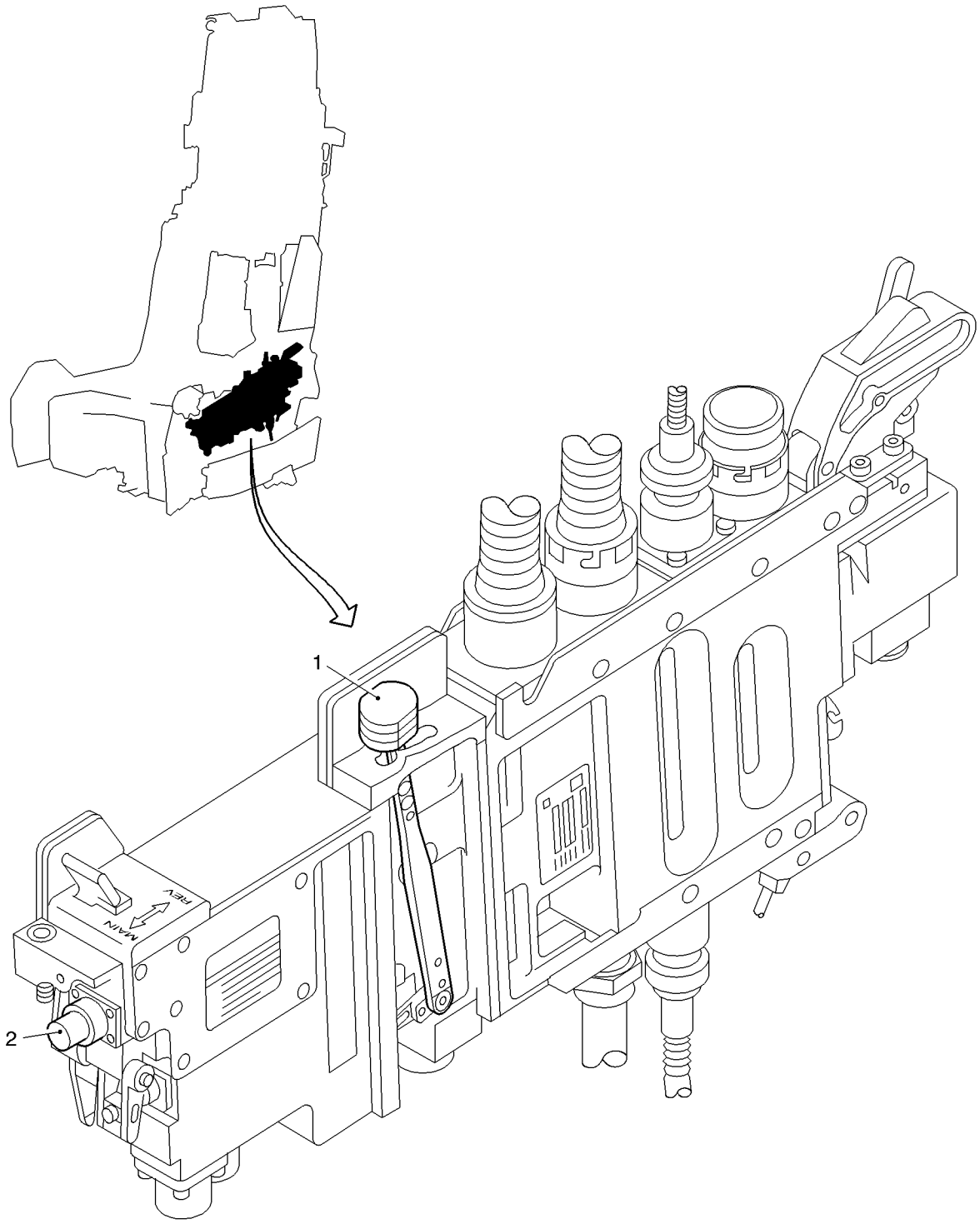
The anti-G valve is fitted with a manual ON/OFF lever, and incorporates a press-to-test facility.

Anti-G Valve Control

A two position lever (2, Figure 1.153), operable in forward and rear positions with a detent at each position, controls the anti-G valve. In the forward position (ON) the anti-G trousers pressure is controlled automatically and varies in accordance with the G level. In the aft position (OFF) the anti-G valve inlet is isolated to inhibit the trousers pressurization, and the current trousers pressure is reduced (vent) to a minimum.

Anti-G Valve Press-To-Test Button

Pre-flight checks of the anti-G valve, including pressure breathing with G, are with the anti-G valve press-to-test button (1, Figure 1.153). When the button is pressed the anti-G trousers pressure increases, which also generates a corresponding breathing pressure increase.



1 ON/OFF CONTROL LEVER
2 PRESS-TO TEST BUTTON

Figure 1.153 - Anti-G Valve - Controls

LIGHTING SYSTEM

Lighting System

(1B-B-33-00-00-00A-043A-A Issue 004)

External Lighting

The external lights can be switched on or off by use of the external lighting controller (Figure 1.154). When selected to off the push button indicator is lit. External lighting consists of the following:

– Navigation lights
– Anticollision lights
– Formation lights
– Landing and taxi lights.

Navigation Lights

The navigation lights consist of a red light mounted centrally on the left wing tip pod, a green light mounted centrally on the right wing tip pod and a white light on the trailing edge of the upper fin. The three lights are controlled by a three position switch, labeled NAV - BRT/DIM/OFF, which is located on the right console.

Anticollision Lights

Two high intensity strobe lights, mounted on the upper and lower surface of the fuselage. They are controlled by a two position switch, Figure 1.154 , labeled A COLL - WHITE/OFF, which is located on the right console.

Formation Lights

Eight formation light units, each having two or three green lights, are mounted on the aircraft. Selection and brightness is controlled by a rotary switch, labeled FORM - OFF, which is located on the right console.
The formation light units are located as follows:

– Forward fuselage, left side (three green)
– Forward fuselage, right side (three green)
– Fin leading edge, left side (three green)
– Fin leading edge, right side (three green)
– Left wing tip pod, top (two green)
– Left wing tip pod, bottom (two green)
– Right wing tip pod, top (two green)
– Right wing tip pod, bottom (two green).

Landing/Taxi Light

Two combined landing and taxi lights are mounted on the main landing gear doors. Each light incorporates two halogen bulbs and are controlled by a three position switch, labeled LAND/OFF/TAXI, which is located on the left quarter panel. Power to the lights is only available when the landing gear lever is in the down position.

Internal Lighting

Illumination of the main cockpit displays, instrument panels and consoles is provided by electroluminescent panels, floodlights and illuminating push buttons and indicators. Controls are shown in Figure 1.154 .

The location of the internal lighting controls in the rear cockpit is shown in Figure 1.155 .

The internal lighting system maintains adequate display visibility throughout the full operational ambient illumination range, with minimum aircrew intervention. In addition, a reversionary capability is provided, allowing a limited amount of cockpit lighting to be available under certain failure conditions.

Power and control of the internal lighting is provided by a lighting controller unit in conjunction with ambient light sensors and lighting controls.

Lighting Controller Unit

The controller unit receives inputs from the internal lighting controls, located on the right console, the MHDD offset controls, the HOTAS lights kill function and a number of light sensors located in various parts of the cockpit.

The controller comprises a power control unit, to control cockpit lighting and display brilliance, and a lighting computer to control the lighting levels of the following:

– Glareshields
– Multifunction Head down Displays (MHDD)
– Dedicated Warnings Panel (DWP)
– Head up Panel (HUP)
– Dedicated push buttons and indicators.

NOTE

The HUD is autonomous with respect to the lighting controller.

Ambient Light Sensors

Two light sensors (rear facing) in each MHDD and two mounted on the glareshields (forward facing) provide inputs to the lighting computer.

NOTE

Two sensors are incorporated in the PDU of the HUD, which are used for the HUD autobrightness function. These sensors do not provide inputs to the lighting controller.

Cockpit Lighting Controls

The cockpit lighting controls are described as follows:

Lighting Mode Switches

The cockpit lighting mode is controlled by a combination of switches:

– Reversionary lighting selector
– Lighting system mode controller
– Antiflash controller.

The reversionary lighting selector is a four position rotary control, labeled NORM/REV LIGHTS - HIGH/ MED/LOW. When this selector is set to NORM the lighting system mode selector is enabled.

The lighting system mode selector is a three position switch, labeled DAY/NIGHT/REV. Depending upon switch setting the following is apparent:

DAY	The lighting system determines the ambient lighting conditions and adjusts the lighting to ensure a constant level.
NIGHT	The automatic functions are disabled, allowing the cockpit lighting to be manually adjusted via the zone dimmer controls and the MHDD brightness offset controls.
REV	The reversionary lighting selector can be used to override lighting controller operation (one of three fixed lighting settings can be used; HIGH, MED or LOW).

NOTE

Each MHDD has a brightness offset control, which allows a limited degree of manual override.

The antiflash controller is a three position switch, labeled A FLASH - BRT/OFF/DIM. With the reversionary lighting selector set to NORM, and this switch set to BRT or DIM, the luminance level of all illuminated cockpit displays is forced to a predetermined level (not floodlighting).

Setting the antiflash controller to BRT or DIM allows the aircrew to counter the effects of sudden ambient light increases or decreases respectively. With the switch in one of these positions the following lighting control system functions is unavailable:

– HUD luminance control
– Automated response to changes in lighting levels (DAY mode)
– All zone luminance controls (NIGHT mode)
– MHDD luminance offset controls.

Zone Dimmer Controls

Three rotary controls, labeled GL SHIELD, DISP and CONSL, allow manual adjustment of display lighting levels when the lighting system mode selector is set to NIGHT (providing the antiflash controller is set to OFF).

Rotating the individual controls, increases or decreases the lighting levels of the displays and panels as follows:

– GL SHIELD controls the lighting levels of the displays located on the left and right glareshields and the HUP
– DISP controls the lighting levels of all MHDD, the displays on the left and right quarter panels, the DWP and fire buttons
– CONSL controls the lighting levels of the left and right consoles and pedestal panel.

Floodlight Controls

A dual concentric rotary control, labeled FLOOD - FWD/AFT, enables the forward panels (MHDD and quarter panels) and the left and right consoles to be illuminated and adjusted. A general low level of illumination is also provided when external ambient light conditions are inadequate.

The kneepad area is floodlit by lap lights, mounted on the canopy frame. The switching and dimming controls for these lights are integral and are therefore independent of the lighting control system.

Lights Kill Switch

The lights kill switch is provided to minimize canopy reflections. It allows selection/deselection of the floodlights, console electroluminescent panels and console/pedestal panel dedicated indicators.

The lights kill function is initiated via the HOTAS controls (Hands on Throttle and Stick pag. 1-107), and is only available when the lighting system mode controller is set to NIGHT. When selected the luminance of the displays under the authority of this function is set to zero. Deselection of the function is

initiated via the HOTAS controls or by selection of another lighting mode.

NOTE

If a failure of the lighting controller unit occurs while the kill function is selected the floodlights will automatically be reinstated.

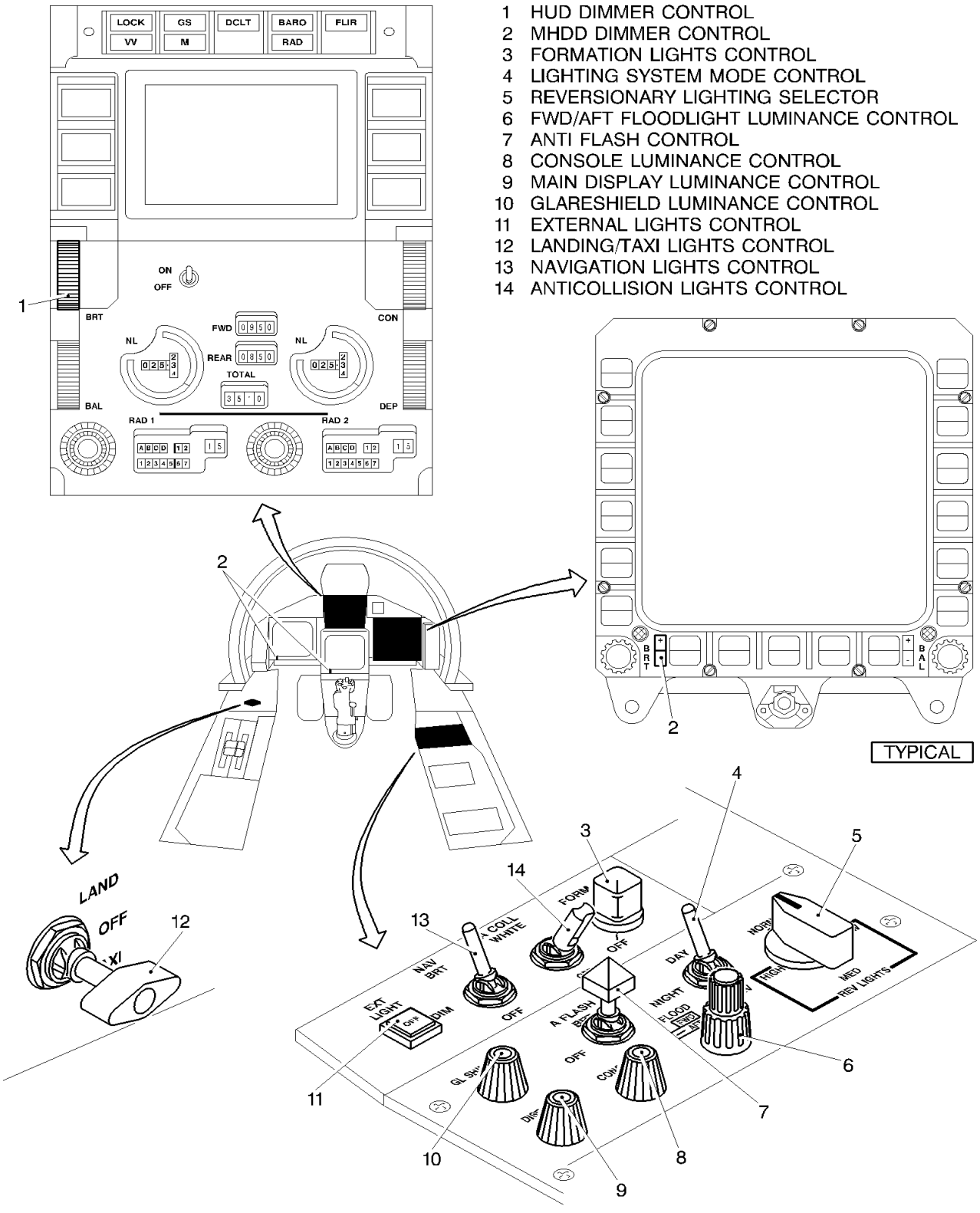


Figure 1.154 - Lighting Controls

1 HUD DIMMER CONTROL
2 MHDD DIMMER CONTROL
3 GLARESHIELD LUMINANCE CONTROL
4 ANTI FLASH CONTROL
5 LIGHTING SYSTEM MODE CONTROL
6 REVERSIONARY LIGHTING SELECTOR
7 FWD/AFT FLOODLIGHT LUMINANCE CONTROL
8 CONSOLE LUMINANCE CONTROL
9 MAIN DISPLAY LUMINANCE CONTROL

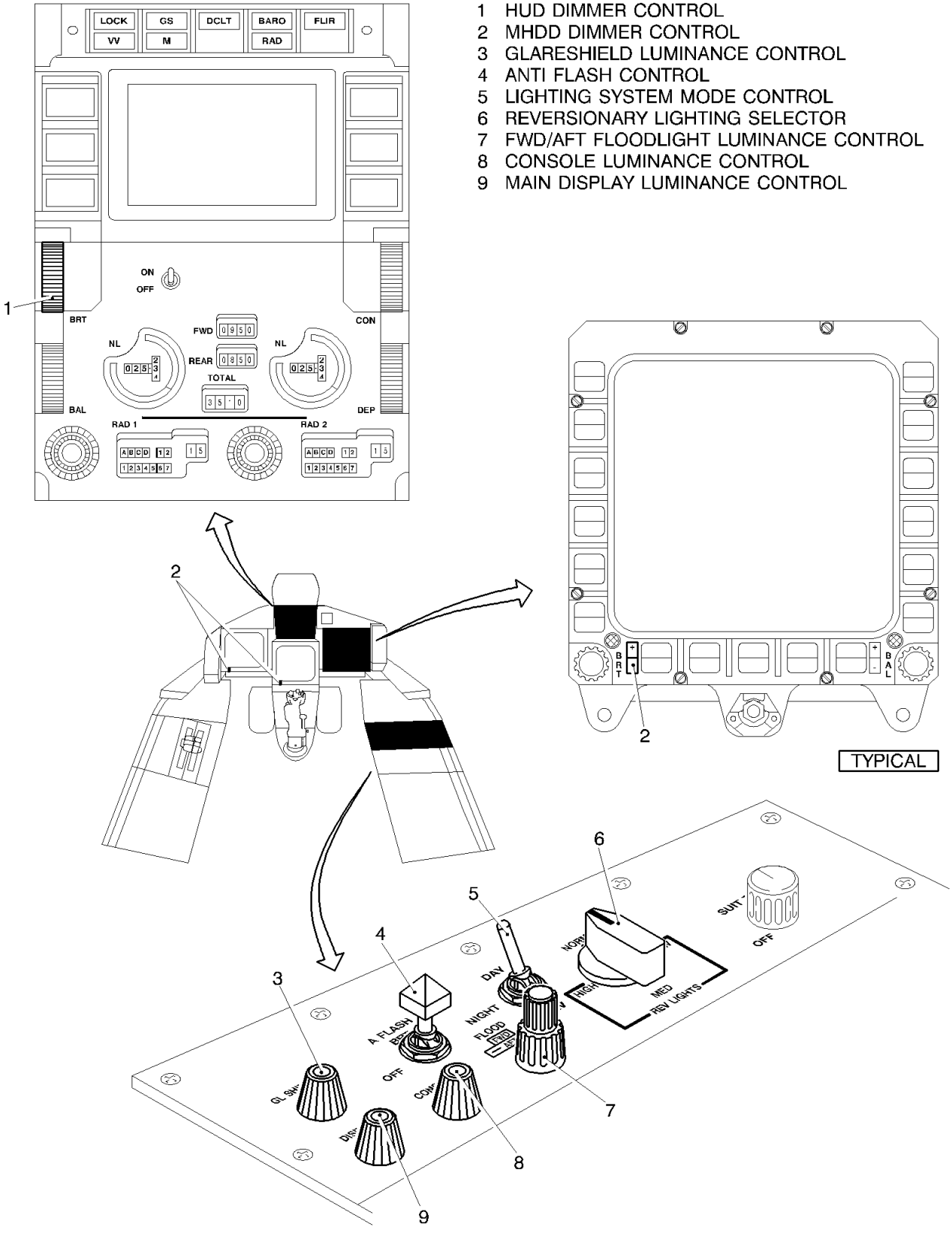


Figure 1.155 - Lighting Controls (Rear Cockpit)

AVIONIC SYSTEM INTEGRATION

Avionics System Integration

(1B-B-40-20-10-00A-043A-A Issue 003)

Introduction

The avionics systems are integrated using multiple, dual redundant databus networks which provide system integrity after system failures and/or battle damage. Data transfer between the systems is achieved using STANAG 3838 and STANAG 3910 databus networks, video and synchronization links, and dedicated data links.

Avionic Systems Databus Operations

Each data bus comprises two independent channels A and B. There are two databus controllers; primary and secondary, with the exception of the defensive aids and radar bus. Both bus controllers monitor their own and each others operation. Should the primary fail then the secondary will automatically take over control; Table , “Avionic Systems Primary and Secondary Bus Controllers,” on page 1-327 lists the primary and secondary bus controllers for the avionic systems. The system LRI are connected to the buses via remote terminals to buses A and B. The databus controlling software is stored within the bus controllers.
The STANAG 3838 (mil-std 1553B) is a low speed databus, transmitting data at 1MHz. The STANAG 3910 is a dual speed databus, transferring control signals on a mil-std 1553B bus and data at 20MHz on a fiber optic bus. The avionics system is interconnected via the following aircraft databuses:

– STANAG 3910
  - Avionic
  - Attack

– STANAG 3838
  - Cockpit
  - Weapons
  - Defensive aids
  - Radar.

Avionic Systems Primary and Secondary Bus Controllers

DATABUS	PRIMARY BUS CONTROLLER	SECONDARY BUS CONTROLLER
Avionic	Navigation computer	Attack computer
Attack	Attack computer	Navigation computer
Cockpit	Cockpit Interface Unit 1 (CIU1)	Cockpit Interface Unit 2 (CIU2)
Weapons	Primary channel of the Non Safety Critical Armament Controller (NSCAC)	Secondary channel of the Non Safety Critical Armament Controller (NSCAC)
Defensive Aids	Defensive Aids Computer (DAC)	None
Radar	Radar processor	None

Databus Start-up/Restart

On application of power the aircraft systems and each LRI perform their own PBIT. Failures detected within a LRI are indicated on the Dedicated Warning Panel (DWP). Databus operations are initiated and both the primary and secondary bus controllers check the validity of each others operation. Successful completion of PBIT by all subsystems and LRI is indicated on the Multifunction Head Down Display (MHDD) autocue format.

If databus controller failure occurs on the ground it may automatically be reconfigured back into the system in its prime role. This will only occur if the fault subsequently clears and the bus controller passes CBIT. If a failure occurs with a bus controller whilst airborne, it will not be reconfigured back into the system even if the fault clears. If a total power failure occurs whilst airborne, then the first bus controller on line having passed PBIT will take control of both buses (where applicable) when power is restored.

The DWP will enter the reversionary mode of operation if both of the cockpit or avionic databuses fail, or if both Cockpit Interface Units (CIU) or Computer Symbol Generators (CSG) fail, refer to Audio/Visual Warnings pag. 1-434.

Secondary Bus Controller Limitations

With the current software version it is possible that the secondary controller may not take over all the responsibilities of the primary and some functions may be lost. The consequences of bus controller failures are listed below.

Navigation Computer Failure

In the event of a navigation computer failure, navigation control is assumed by the Attack computer, resulting in the following consequences:

– Climb/dive angle displayed has reduced integrity
– The low height warning is lost
– Navigation and steering displays extinguished
– LINS available for flight path displays only
– TACAN data available

Attack Computer Failure

In the event of an attack computer failure, attack bus control is assumed by the Navigation computer, resulting in the following loss of functionality:

– All radar
– IFF MODE C (heighty transmitted, 0 ft)
– IFF mode selection
– IFF NORM/STBY selection
– IFF IDENT

Single/Double CIU Failure

In the event of an attack computer failure, attack bus control is assumed by the Navigation computer, resulting in the following:

– The cockpit data bus is disabled
– The DWP switches to reversionary mode
– The MHDD soft-keys and the HUD moding are inoperative
– The left glareshield is not lit
– Switches and controls for systems that interface via the CIU are inoperatiive.

Weapons System Failures

In the event of the weapos system failures, the following functionalities are lost:

– Emergency Jettison
– Selective Jettison
– MHDD/STOR format
– Stores configuration data to FCS
– Missile Firing
– Gun

Databus Architecture

Figure 1.156 gives an overview of the avionics databus architecture. The avionic system consists of the following seven subsystems:

– Communications (COMMS)
– Integrated Monitoring and Recording Subsystem (IMRS)
– Navigation (NAV)
– Display and Controls (D&C)
– Attack and Identification (A&I)
– Defensive Aids Subsystem (DASS)
– Armament Control Subsystem (ACS).

Communications Subsystem

The communications subsystem consists of:

– The Communications and Audio Management Unit (CAMU)
– V/UHF transceiver 1
– V/UHF transceiver 2
– Combined fin tip antenna
– Lower antenna.

The CAMU, VHF1 and VHF2 are interconnected by dedicated links and to the avionic bus. The connection between each LRI and databus is shown in Figure 1.157.

Integrated Monitoring and Recording Subsystem

The IMRS consists of the following LRI:

– Interface Processing Unit (IPU)
– Crash Survivable Memory Unit (CSMU)
– Sensor and Signal Conditioning Units (SSCU)
– Video/Voice Recorder (VVR)
– Mission Data Loader and Recorder (MDLR), and the Portable Data Store (PDS)
– Bulk Storage Device (BSD).

The LRI are interconnected via the avionic bus, the attack bus, the utilities control bus and dedicated links. The connections between each LRI and the databuses is shown in Figure 1.158 .

Navigation Subsystem

The navigation subsystem consists of the following LRI:

– Navigation computer
– Laser Inertial Navigation Subsystem (LINS)
– Global Positioning Subsystem (GPS)
– Radar altimeter
– Tactical Airborne Navigation (TACAN).

The LRI are interconnected via the avionic bus and dedicated links. The connections between each LRI and databus is shown in Figure 1.160 .

Displays and Controls Subsystem

The displays and controls subsystem consists of the following LRI:

– HUD
– HUD video camera
– Six MHDD
– Left glareshield (front and rear cockpit)
– Right glareshield, including the Get-U-Home (GUH) reversionary instruments (front and rear cockpit)
– Four CIU

– Two CSG
– Lighting controllers
– Two Dedicated Warning Panels (DWP)
– Digital Map Generator (DMG)
– Stick top controller (front and rear cockpit)
– Throttle top controller (front and rear cockpit).

The LRI are interconnected via the cockpit bus, the avionic bus, the utility control bus, video and synchronization links and dedicated links. The connections between the LRI and databuses are shown in Figure 1.161.

Attack and Identification Subsystem

The attack and identification subsystem comprises:

– Search radar
– Attack computer
– IFF interrogator/transponder.

The attack and identification LRI are interconnected via the attack bus, the avionic bus and dedicated links (Figure 1.162).

Defensive Aids Subsystem

The defensive aids subsystem comprises:

– Defensive Aids Computer (DAC)
– Chaff dispensers
– Flare dispensers.

Interconnection of the LRI is via the defensive aids bus, the attack bus and dedicated links.

Armament Control Subsystem

The ACS consists of the following LRI:

– Safety Critical Armament Controller (SCAC)
– Non Safety Critical Armament Controller (NSCAC)
– Distribution Units (DU)
– Fuselage Station Units (FSU)
– Six Wing Pylon Station Units (WPSU)
– Two Integrated Tip Station Units (ITSU)
– Master Armament Safety Switch (MASS)
– Two Armament Safety Break Contactor (ASBC)

The ACS LRI are interconnected by the weapons bus, attack bus and by dedicated links (Figure 1.163). The weapons audio signals are routed to the CAMU, and weapons video signals are routed to the CSG via the DU.

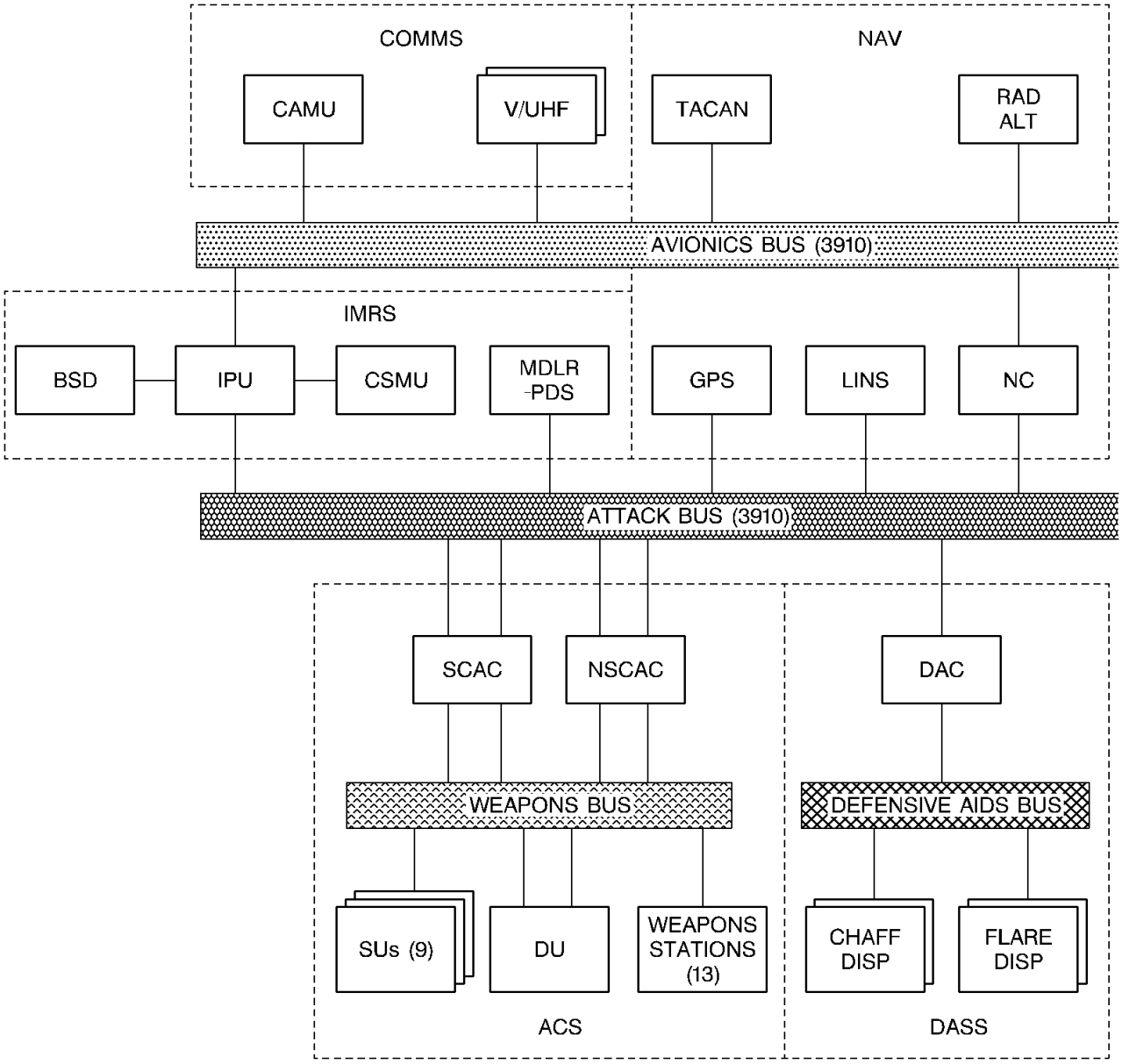


Figure 1.156 - Avionics Databus Architecture (Sheet 1 of 2)

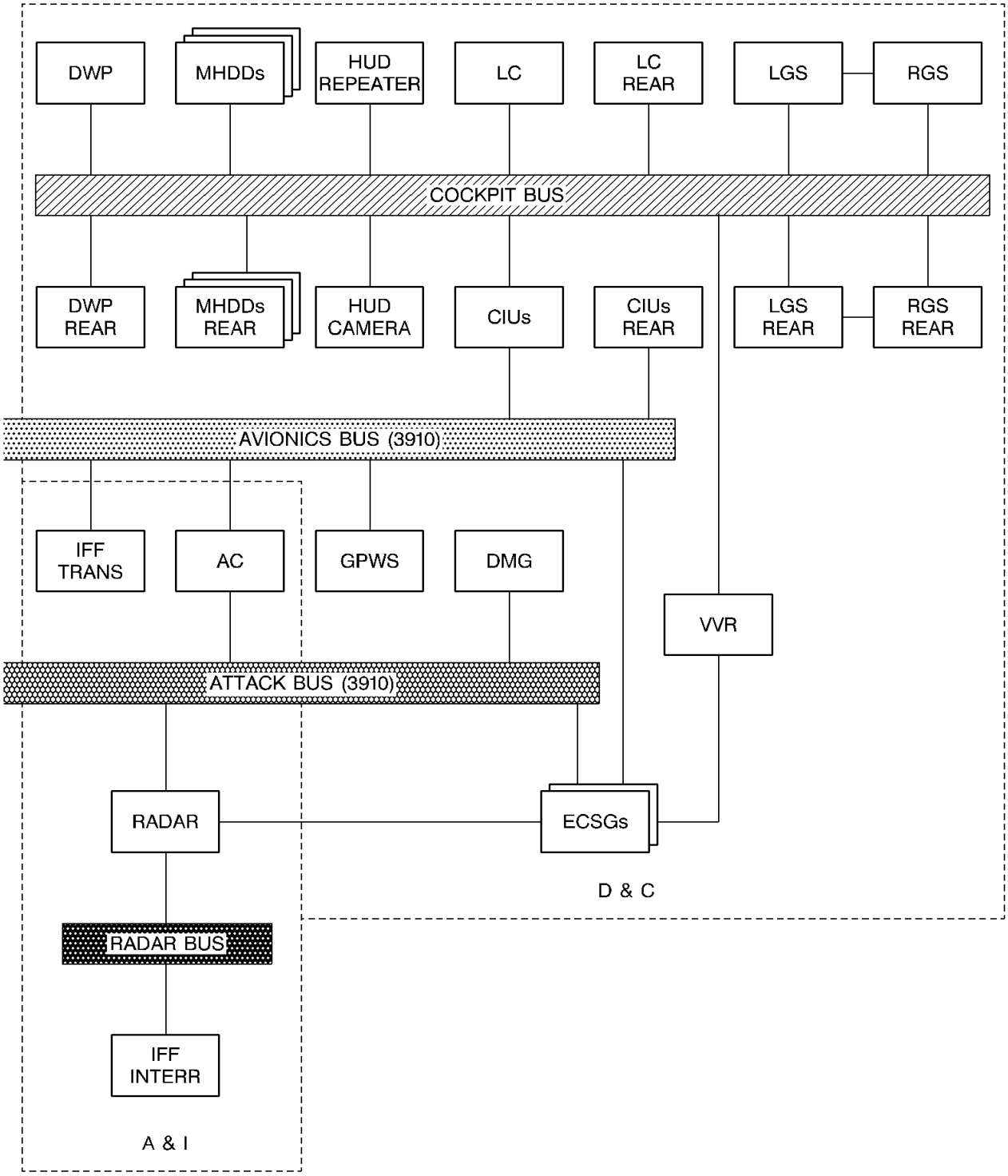


Figure 1.156 - Avionics Databus Architecture (Sheet 2 of 2)

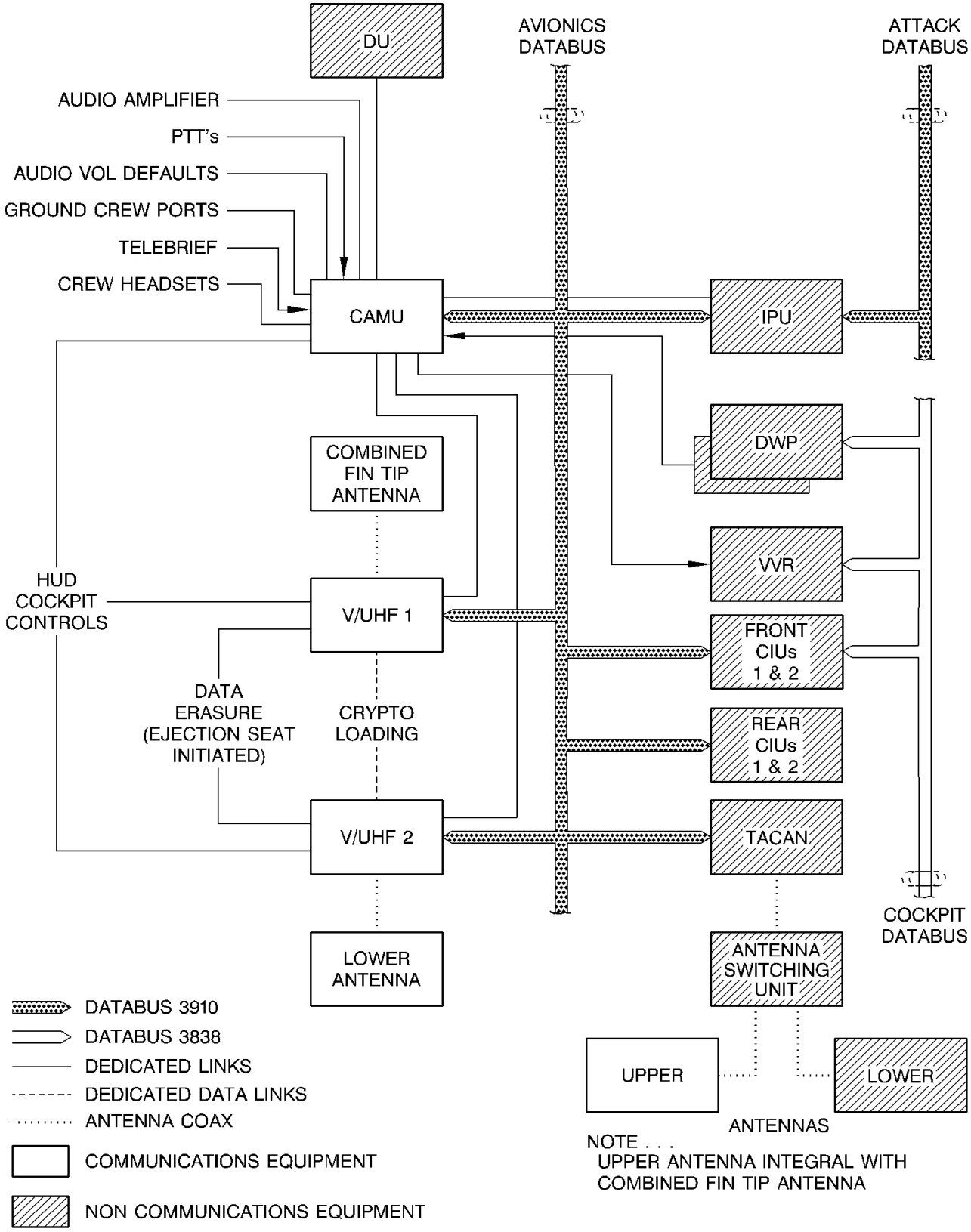


Figure 1.157 - Communications Subsystem Architecture

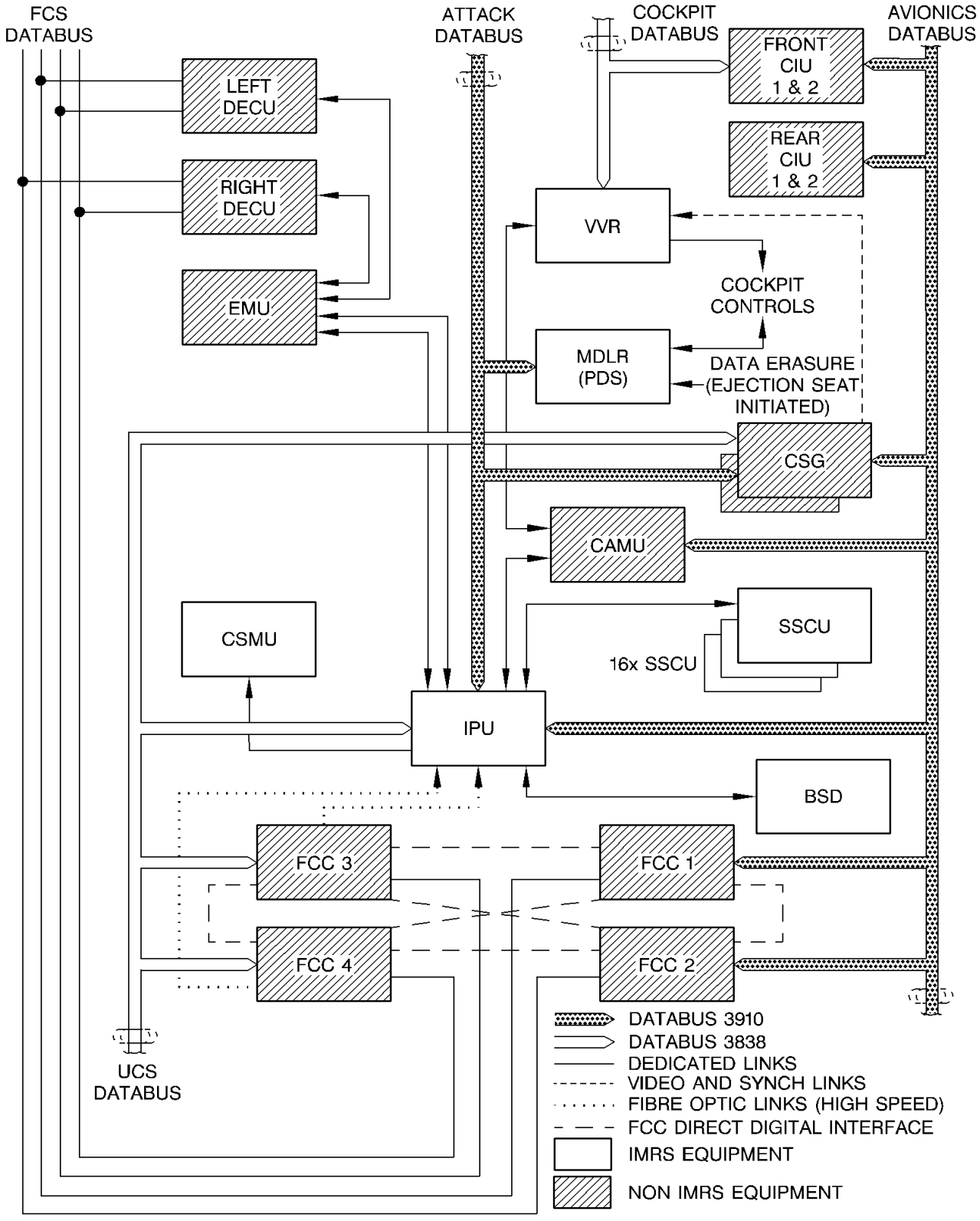


Figure 1.158 - Integrated Monitoring and Recording Subsystem Architecture

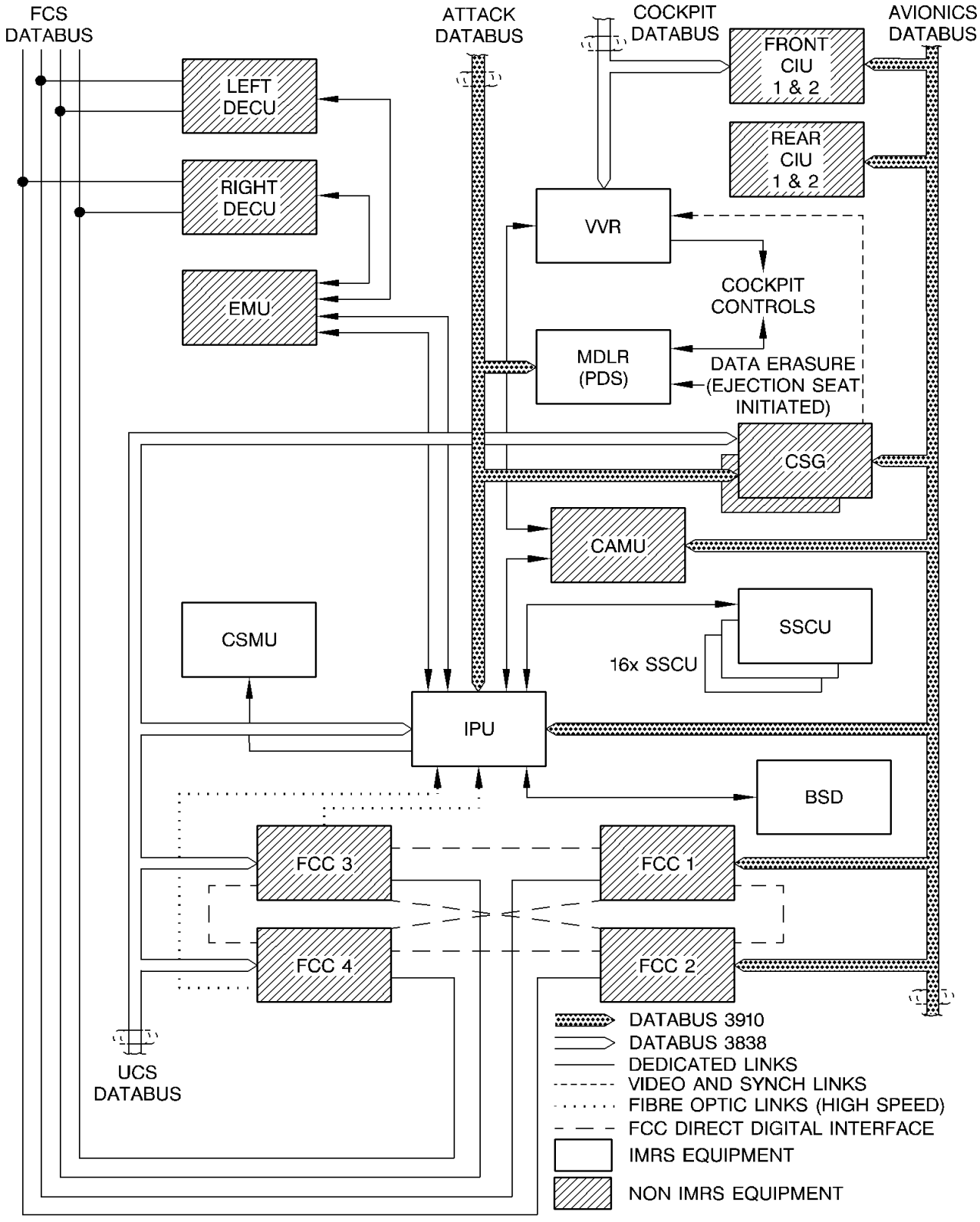


Figure 1.159 - Integrated Monitoring and Recording Subsystem Architecture

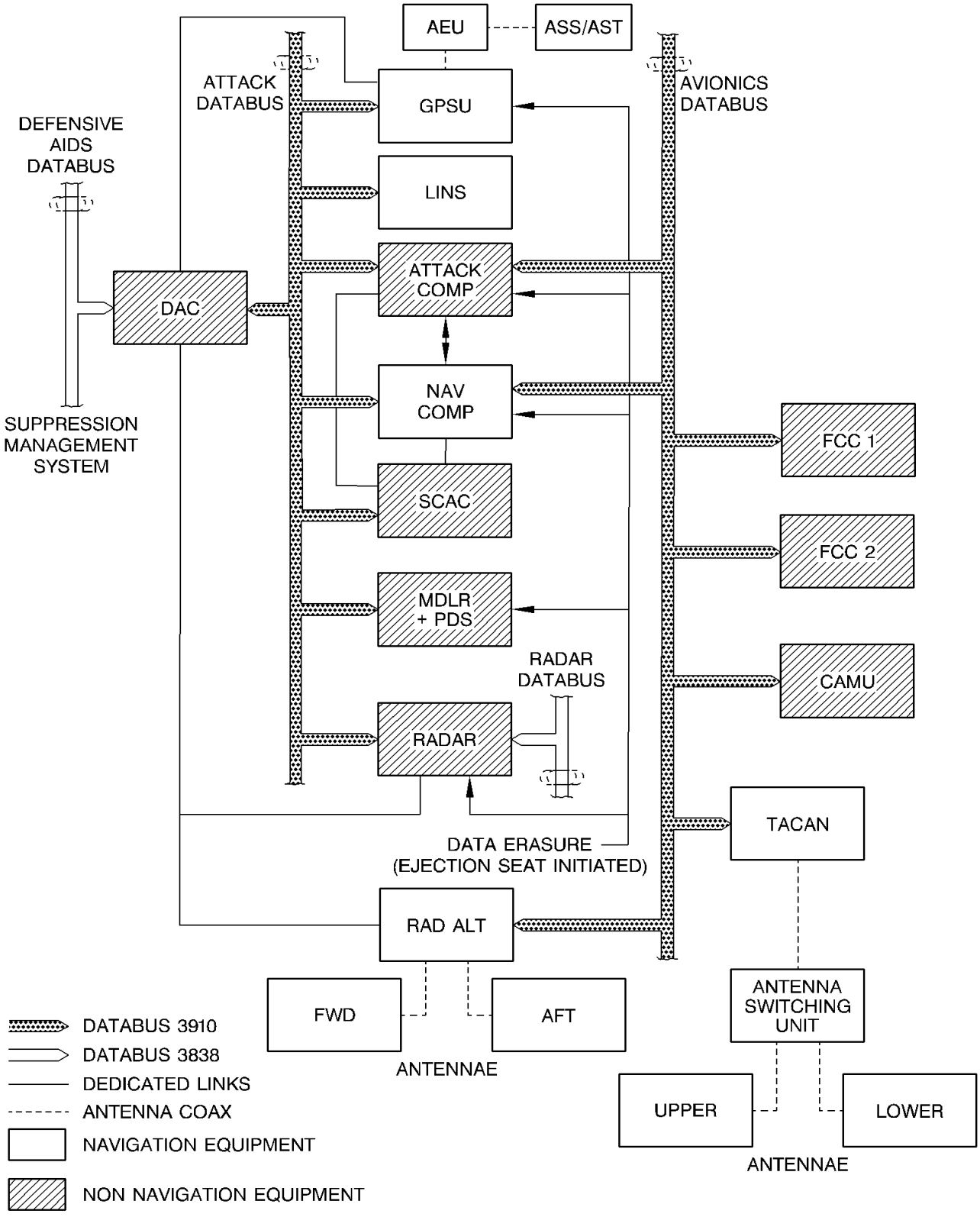


Figure 1.160 - Navigation Subsystem Architecture

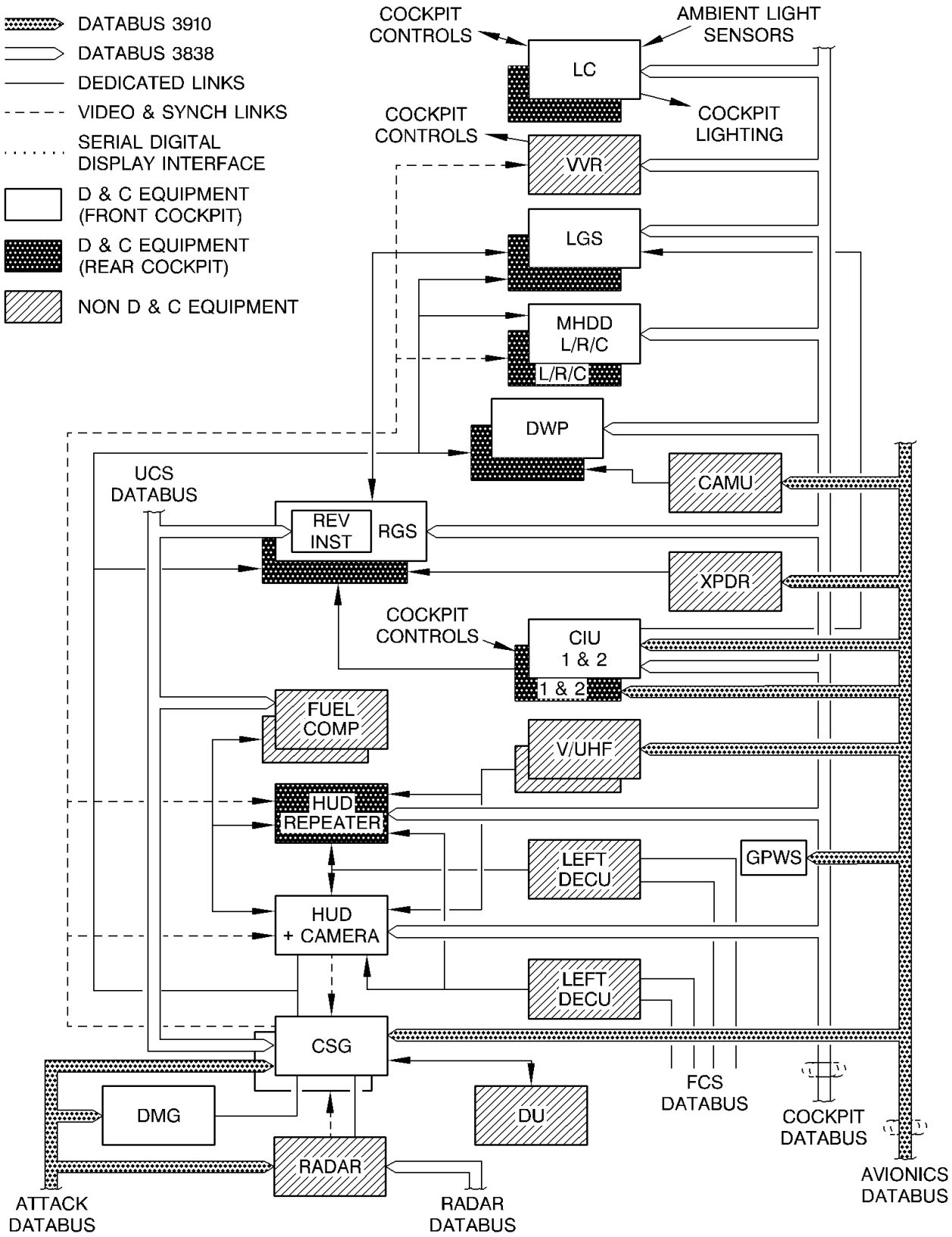


Figure 1.161 - Displays and Controls Subsystem Architecture

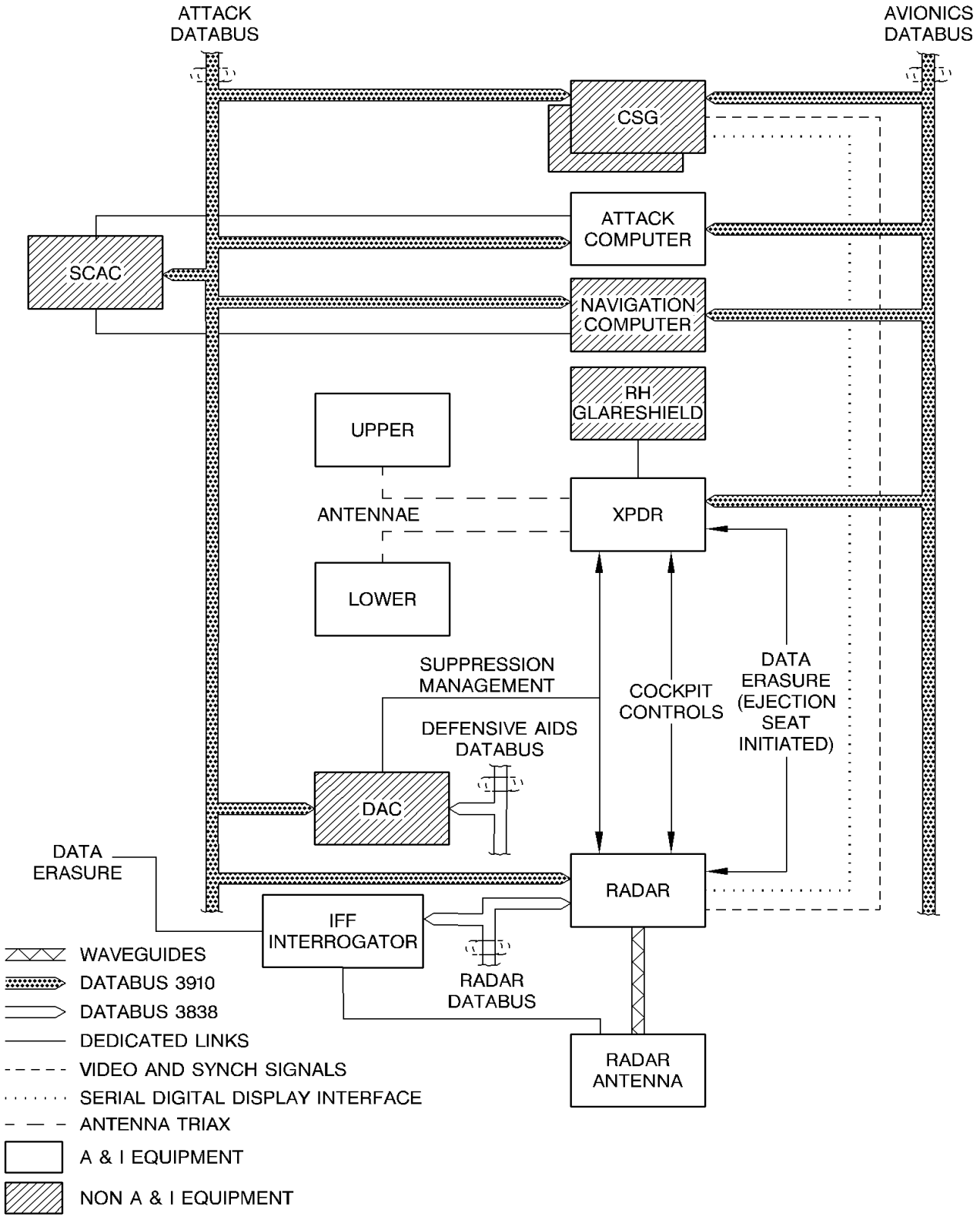


Figure 1.162 - Attack and Identification Subsystem Architecture

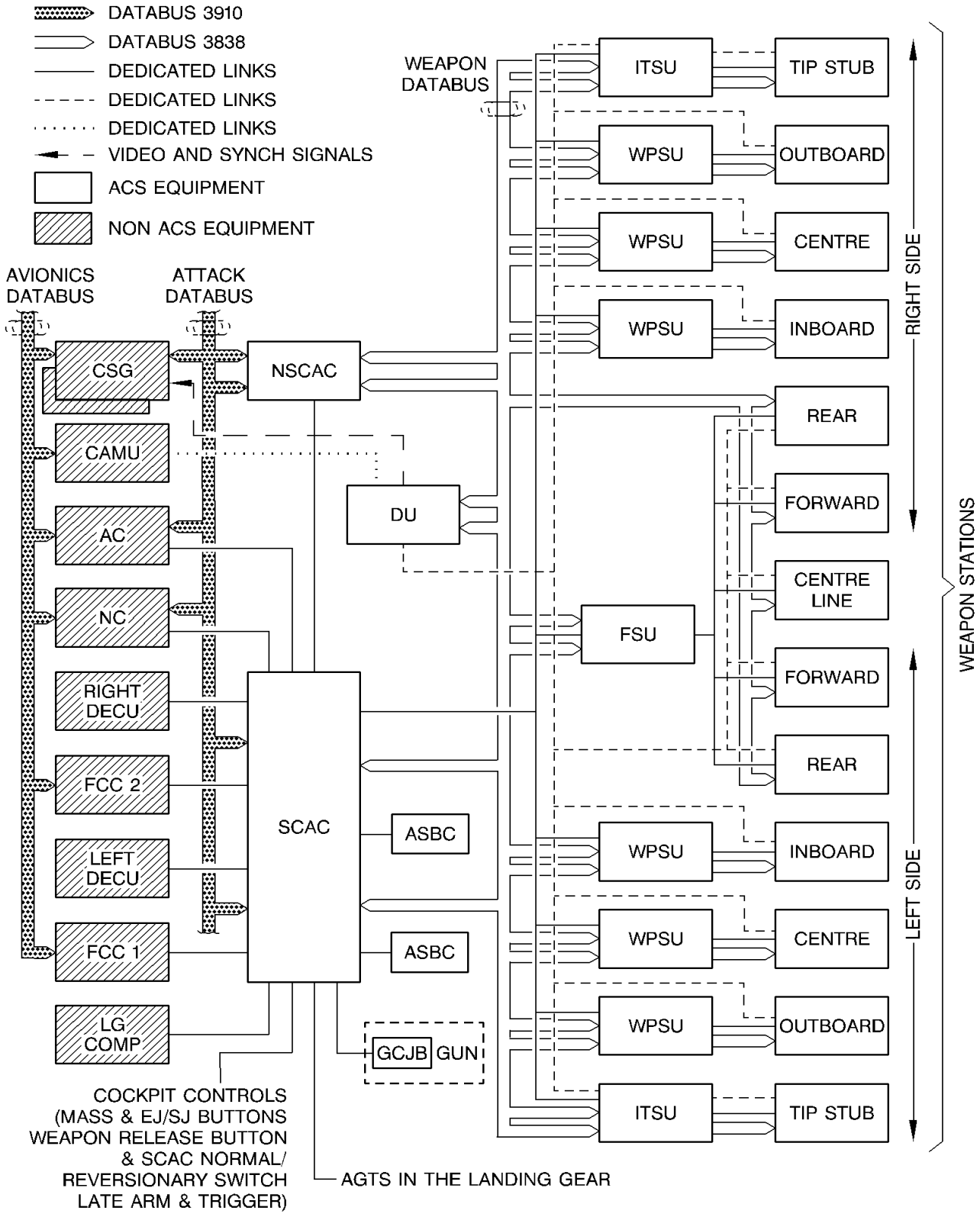


Figure 1.163 - Armament Control Subsystem Architecture

System Software

(1B-B-40-30-00-00A-043A-A Issue 002)

Introduction

Every aspect of aircraft operation is directly affected and controlled by the software loads comprising the various system packages.
The application software is normally loaded direct to the various Line Replaceable Item (LRI), while mission dependant data can be loaded pre-flight through the Ground Loading Unit (GLU) and/or the Portable Data Store (PDS).

Software Standards

The main application software can be considered to be of two standards, Class 1 and Class 2. Although there is a Class 3 software standard, this effects maintenance applications only.

Class 1 Software

Class 1 software is rigorously developed and tested to provide the highest integrity. It is used for safety critical functions, i.e. those functions where a failure or fault within the software could cause a serious or even a catastrophic risk to the aircraft, pilot or to third parties on the ground or in the air.
Class 1 software is utilized in the following:

- Flight Control System (FCS)
- Safety Critical Armament Controller (SCAC)
- Armament Control System (ACS), part off
- Digital Engine Control Units (DECU)
- Computer Symbol Generators (CSG), part off
- Head-up Display (HUD), that provides high integrity, back path monitored, flight path displays
- Left and right fuel computers
- Landing gear computer.

Class 2 Software

Class 2 software is designed to a similar standard as Class 1 software but is tested to a less stringent standard. This software is used for functions where a failure would not result in a serious or catastrophic hazard. In pilot operating terms, there is little difference between the two software standards. The only visible effect being that some post system failure drills are affected by the degree of safety assumed for the underlying operating software standard.
Class 2 software is utilized in the following:

- Cockpit Interface Unit (CIU)
- Interface Processor Unit (IPU)
- Non Safety Critical Armament Controller (NSCAC)
- Mission Data Loader Recorder (MDLR)
- Crash Survivable Memory Unit (CSMU)
- Defensive Aids Computer (DAC)
- Computer Symbol Generators (CSG)
- Communication and Audio Management Unit (CAMU)
- Secondary Power System (SPS) left and right computers
- Engine Monitoring Units (EMU)
- Maintenance Data Panel (MDP)
- Navigation computer
- Attack computer
- Radar system
- Lighting controller.

NAVIGATION SYSTEM

Navigation System

(1B-B-34-00-00-00A-043A-A Issue 005)

general

The Navigation System provides the weapon system with accurate navigational position and velocity vector data, and provides the pilot with navigation and flight path control display. The main role of the Navigation System is to enable the aircraft to be flown to a specified destination from a specified departure. It derives the essential flight data (speed, direction, height, attitude) from on-board sensors of relevant subsystem and then supplies this data to the Navigation Computer (NC) for navigation function computation.
The Navigation System consists of the following equipments:

- Laser Inertial Navigation System (LINS). This on-board sensor is the primary sensor for dead reckoning navigation. It provides present position (latitude, longitude), true heading, bank, inclination, climb/dive angle, body rates, baro/in altitude, direction cosine matrix, aircraft attitudes, tridimensional velocities and accelerations (linear and angular).
- Global Positioning System Upgradable (GPS). It provides time, present position, tridimensional velocities, climb/dive angle and altitude.
- Radar altimeter (RADALT). It provides height above any type of surface up to 5000 ft.
- Navigation Computer (NC). This dedicated computer uses data from the LINS and from the other systems and sensors to compute Best Navigation Data, navigation steering and weapon aiming parameters. If the LINS is invalid the Flight Control System (FCS) supplies the data.
- Integrated Tactical Air Navigation (ITACAN) equipment provides range and bearing with

respect to the selected TACAN station. These information are displayed on the MHDD Pilot Awareness (PA) format. It will support A/G and A/A modes. In each mode the RX and RX/TX modes as well can be selected, according to the pilot selection and/or stealth status.

To update the NAV store/manual route and to navigate in reversionary mode the Navigation System uses some equipment which are part of the FCS system, they are:

– Inertial Measurement Units (IMUs)
– Air Data System (ADS)
– Flight Control Computers (FCC).

Navigation Functions and Navigation Data Generation

The LINS data are used as primary dead reckoning navigation information while the FCS data as secondary source.
LINS and FCS data are used by the Navigation Computer to generate the best navigation data at required accuracy and update rates.
They are also used by the Kalman Filter (KF) to evaluate and update the present position error when a fix procedure (NAV Mode 3) has been performed by the pilot or when continuously making a comparison with GPS data.
Best Navigation Data output by Navigation Computer are sent to the AVS users and FCS system and also used internally by the NC for other Navigation functions (e.g. Steering, Rad/Alt inhibition, etc.). The following NC functionalities will be provided by the system:

BC initialization.
After power up phase the NC performs the PBIT function and, on completion, the Purchaser Provided Software (PPSW) starts. The NC correctly initializes itself in normal mode, i.e. as Bus Controller (BC) on the AVS Bus and as Remote Terminal (RT) on the Attack Bus.
Primary Bus Controller on AVS Bus.
It includes the correct behavior when controlling the input/output data, the shifting and the management of the acyclic requests performed by the NC on Low and High speed data Buses.
Reversionary Bus Controller on Attack (ATK) Bus (in case of AC failure).
It includes the correct behavior when controlling the input/output data, the shifting and the management of the acyclic requests performed by the NC on Low and High speed data Buses.
Cockpit Interface Unit/Computer Symbol Generator (CIU/CSG) and R-CIU Master/Slave Management.
The NC monitors the CIU/CSG/R-CIU LRI status in order to command the operative unit as master when the CIU/CSG/R-CIU NORM/REV switch is selected to NORM, otherwise the CIU2/CSG2/R-CIU2 is commanded as Master.
Health Monitoring.
The NC monitors the AVS RTs status in Normal Mode and AVS/ATK RTs status in Reversionary Mode in order to determine the GO/NOGO LRI's status and so to correctly handle the transactions either disabling them when the RT is declared faulty or by activating them when an RT is recovered from a failure.
Maintenance Data Generation.
The NC produces a maintenance data report to the Interface Processing Unit (IPU) based upon PBIT/CBIT/IBIT results and, as BC reports failures recorded for the monitored RTs.
Single/Multi mission data loading.
The Navigation Computer is able to load Single Mission Data/Multiple Mission Data (SMD/ MMD) via PDS/GLU.
Inertial Navigation.
The prime Dead Reckoning Navigation function is provided by the LINS. The secondary Dead Reckoning Navigation function uses air data and attitudes provided by FCS.
Best Data Generation.
The NC produces the Best Navigation data integrating the automatic navigation aids (GPS) or manual fixing (OTF) to refine the dead reckoning performance, using Kalman Filter technique, when LINS modes are available. FCS can be used as reversionary for LINS. In case of LINS failure, best data are produced without Kalman Filter evaluation error.
Moding.
The NC automatically enters the NAV Mode based upon sensors availability or upon manual selection. The system automatically enters LINS GPS1 if both sensors are valid upon LINS NAV selection (via MHDD NAV SEL moding key). The following modes are available:

MODE 1: LINS + GPS + KF (LINS GPS1 legend is lit)
MODE 3: LINS + OTF + KF (LINS FIX1 legend is lit)
MODE 4: LINS + GPS (LINS GPS legend is lit)
MODE 5: LINS + last KF correction + OTF (LINS FIX2 legend is lit)
MODE 6: FCS + GPS (FCS GPS legend is lit)
MODE 8: FCS + OTF (FCS FIX is lit).

All available modes are displayed (lit). The selected one is boxed.
Data Comparison.
LINS horizontal/vertical velocities are continuously compared with GPS ones; LINS attitudes are compared with FCS ones.

Best Height generation/RADALT transmitter (RADALT TX) inhibition.

Best height is measured by RADALT (up to 5000 ft) and displayed on the Head-Up Display (HUD) and on the MHDD/HDHUD format. The RADALT supplies height above surface and the related validity signal. The RADALT height is occulted in case of manual or automatic inhibition. Manual inhibition can be performed via RADALT TX control switch (located on the right console) or XMIT SSK (on left hand glare shield) to silent all the transmitting equipment. Automatic inhibition can be performed by DAC or NC, when bank/inclination exceed ±60 degrees and/or bank/inclination rates exceed ± 60 degrees/second for more than 2 seconds.

Steering Functions.

The NC calculates the information to steer the A/C along a defined route, which can be Automatic or Manual.

Wind Calculation and Selection.

Wind information is calculated by the system when LINS/FCS data are valid, otherwise Set Wind is used as Best Wind.

If Portable Data Store (PDS) set-wind-data have been loaded via Ground Loading Unit/Mission Data Loader and Recorder (GLU/MDLR), then the NC will provide as set wind those data according to the current baro altitude.

Steering Bug Calculation.

The NC calculates the steering azimuth command to acquire and holds the planned track for manual steering of the pilot.

Source of Universal Time Coordinate (UTC).

The source of UTC in the Navigation System is within the GPS.

Generation of Navigation Parameters.

The NC generates navigation parameters such as Direction Cosines and uncertainty of Navigation Data, to support track formation and track correlation.

Magnetic heading calculation.

The LINS, if valid, is the source of Magnetic Heading that is displayed on the Head-Up Display (HUD), on the MHDD/PA format and on the Multi-Function Head-Down Display/Head-Down/Head-Up Display (MHDD/HDHUD) format. The magnetic variation (deduced from the Best Present Position) is subtracted from the Best True Heading to produce the Best Magnetic Heading.

Alternative Source of Climb and Dive Angle.

The GPS and NC provide alternative sources of LINS Climb and Dive angles.

TACAN information. The range and bearing information are sent directly to the MHDD/HSI format. The pilot sets the operating state, mode and channel of the TACAN on MDEF.

Navigation Fixing.

Navigation Fixing functions are Automatic (GPS) and Manual (ON-TOP)

Route Loading and Manipulation.

Up to 200 waypoints (ROUTE STORE) and two routes (AUTO and MANUAL) can be loaded in the Navigation Computer via PDS or manually via D+C. All waypoints (WP) contained in the Route Store can be modified, if required, by the pilot except 10 Mark WP and 3 IFA WP. In both routes, consisting of up to 50 waypoints, only 46 locations are loadable or editable by the pilot because three locations are reserved for IFA and one location for a future MLS Transition Waypoints.

Low Height Warning.

A Warning is generated if the Best Height, measured by the Radar Altimeter, decreases below the Clearance Height set by the pilot on the RHGS "LOW HT" control; the Attention Getters and a voice warning message "Climb climb" immediately warn the pilot of the danger. In addition a pull-up indication is displayed on HUD and MHDD/HDHUD format, shown by a flashing arrow which rotates about its center point such that it always points away from the ground. As soon as best height increases above +3% of CLEARANCE-HEIGHT, the Low Height Warning is reset. The low height warning is generated by the NC during NAV and A/A PoF. A delay of 15 seconds when computing the low height warning has been introduced during transition between T/O and NAV PoF or if NAV has been previously manually selected between Weight-On-Wheels to Weight-Off-Wheels transition.

NOTE

The low height warning must not be used as the sole indication of ground terrain.

Built-in Test Function

LRIs which are part of Navigation System incorporate built in test (BIT) facilities and are able to accomplish failure detection and recovery.

These include:

- Power-up Built-In-Test (PBIT)
- Continuous Built-In-Test (CBIT)
- Initiated Built-In-Test (IBIT).

Dedicated Warning Panel (DWP)

Information on specific Navigation system failures or abnormal conditions are displayed on the DWP and are the following:

– "LINS" - Warning Category 3 in all PoF
– "NAV CPTR" - Warning Category 3 in all PoF
– "RAD ALT" - Warning Category 3 in all PoF
– "GPS" - Warning Category 3 in all PoF
– "MON TRIP" - Warning Category 2 (cat. 3 in GND PoF).

Recovery

The Recovery system runs automatically and continues monitoring on all Remote Terminals (RTs); whenever an equipment (LRI) is in failure the pilot is alerted. The system recovery continues to monitor the LRI in failure and if the origin of failure disappears for any reason, the LRI will be displayed as having recovered.

Navigation Fixing

(1B-B-34-61-00-00A-043A-A Issue 004)

The navigation system automatically selects the optimum navigation mode depending on the sensors available. Normally the system will automatically select and operate in NAV Mode 1 although it is possible to select any other navigation mode using the NAV MODE function key (AIDS SSK) provided that the related sensors are available.

The navigation system is capable of performing either automatic fixing (depending on the GPS availability) or manual fixing, as shown in the Table , “Navigation Fixing,” on page 1-342

Navigation Fixing

NAV MODE	AUTOMATIC FIXING	MANUAL FIXING
1	X	
3		X
4	X	
5		X
6	X	
8		X

Manual fixing is performed using the On Top Fix (OTF) technique only. During a fix procedure, the navigation system provides steering information to overfly the fix point before commencing a turn toward the next track.

NOTE

- Only “overfly” and “landing” Destination Waypoint (DWP) types can be used for OTF procedures.

- It is not possible to perform an OTF against Route, CAP and Mark DWP: if the fix menu is selected when one of these waypoint types is DWP, the FIX-OTF SK is occulted when steering to one of these waypoint types.

The mode is selected via the FIX OTF SK on the MHDD PA format. On selection, the XY cursor is tied to the right side of the MHDD and all other XY functions are inhibited. When overflying the fix point, the XY insert must be pressed. The fix error (NM N/S, E/W) is displayed on the MHDD for the pilot's acceptance or rejection using the FIX ACPT or FIX REJT SKs.
For Mode 3 only, it is shown below the fix error figures, is a recommendation for acceptance or rejection (ACTP or REJT). It is based on the estimated magnitudes of the errors as computed by the Kalman Filter.
Upon accepting or rejecting, the error is cleared from the display and the system automatically changes destination (auto CHD function is inhibited while OTF is selected).

NOTE

Change destination will be active provided the fixing procedure is terminated (either accept or reject) within 2 NM from the current overflown DWP.

The OTF procedure may be cancelled at any time before any fixing has occurred using the FIX REJT SK (refer to Figure 1.164).

Three Navigation modes are available for Manual Navigation Fixing:

– Nav Mode 3
– Nav Mode 5
– Nav Mode 8.

Nav Mode 3 (LINS + OTF + KF, LINS FIX1 boxed on AIDS/NAV MODE)

Following acceptance, the NC updates the PP with the position error calculated by NC Kalman Filter.

NOTE

In order to maintain accurate navigation performance, the OTF operation should be performed about every 20 minutes.

Nav Mode 5 (LINS + OTF, LINS FIX2 boxed on AIDS/NAV MODE)

Following acceptance, the NC updates the PP with the correction derived from the computation between OTF PP and measured PP as sensed by the LINS (with last KF correction if a fixing operation was previously successfully performed).

Nav Mode 8 (FCS + OTF, FCS FIX boxed on AIDS/ NAV MODE)

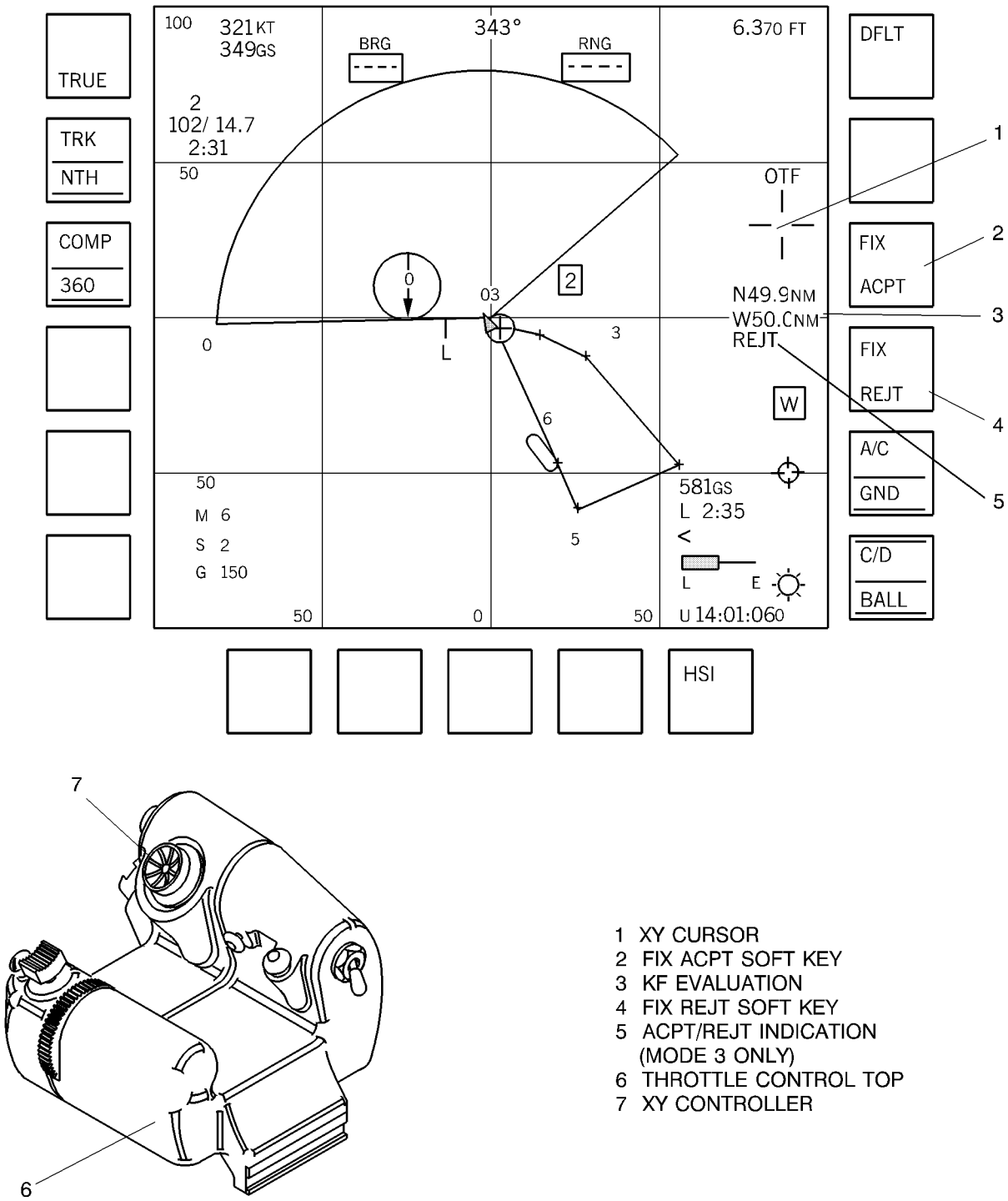
Following acceptance, the NC updates the PP with the correction derived from the computation between OTF PP, the PP derived from the FCS data (TAS, acceleration, altitude and heading) and the last calculated wind before LINS failure.

NOTE

Best data could be degraded because of:

– WIND CHANGES, DUE TO THE METEOROLOGICAL CONDITIONS
– THE NC USES THE LAST VALID WIND WHEN PERFORMING THE A/C VELOCITY CALCULATION.

For this reason the pilot should use the FCS OTF procedure with caution. It is suggested that the OTF procedure should be carried out frequently.



1 XY CURSOR
2 FIX ACPT SOFT KEY
3 KF EVALUATION
4 FIX REJT SOFT KEY
5 ACPT/REJT INDICATION (MODE 3 ONLY)
6 THROTTLE CONTROL TOP
7 XY CONTROLLER

Figure 1.164 - Insert On Top Fix

Navigation Steering

(1B-B-34-62-00-00A-043A-A Issue 006)

Navigation Steering

The Navigation Steering calculation is provided for manual steering. The system provides the pilot with some parameters that enable him to steer the aircraft along a route constructed of a series of legs, where a leg is that part of a route between two successive waypoints.

On power up, the AUTOmatic route is selected as the default route. The pilot can select between Automatic route and Manual route both on the ground and during flight via the MDE NAV subsystem key.

After takeoff (weight-off-wheels and NAV PoF), the steering data is displayed to the pilot to guide the aircraft to the destination waypoint (DWP). Direct Steering is the default steering mode, but the pilot can select Track steering if required using the MDE NAV subsystem key.

ROUTES

The navigation system can manage two different routes: an Auto route (planned) and a Manual route (unplanned); both can be pre-planned and loaded via MDLR/GLU. Each route can contain up to 50 waypoints.

Normally, the routes will contain at least two waypoints the first one identifying the departure airfield and the second one identifying the destination airfield.

Route Transitions (Join Waypoint)

The system will automatically transfer from one route to the other under certain circumstances. If the system has been flying the Manual route and the last waypoint in this route is also a waypoint in the Auto route, then the system will automatically steer the aircraft to the Auto route from that point onwards. If the pilot selects the Auto route whilst the Manual route is being flown, or the system is in Hold Steering mode, then the system will return to the Auto route using the previously set DWP in that route as the new DWP.

Additional Route Functions

Three extra functions are provided to improve the flexibility of the navigation system. They are all selectable using the MDEF, after selecting the NAV SSK and are as follows:

– Change Direction: This function, selected by pressing the CHNG DIR moding key, reverses the selected route direction and allows the pilot to navigate back along the selected route. The route is completely reversed and the new waypoint order is shown on the Waypoint List format and is displayed on the MHDD/PA format.
– CHD XXX: This facility is only available when there is a preceding waypoint in the route currently being flown that is available for selection. On pressing the CHD key the route sequence is moved back one step, providing steering back to the previous waypoint but retaining the planned route sequence.
– New Track: With Track Acquire Steering engaged, it is possible to define a new planned track from PP to DWP, by selecting the NEW TRK moding key.
– Emergency Airfields: Following navigation computer PDS/GLU mission data loading the NC provides to the pilot (via FCS, D+C) Range and Bearing of the nearest emergency airfields available. This information is displayed on RHGS on reversionary instruments indicators.
– Delete Manual Route: A DEL MAN Moding key on the MDEF allows the deletion of the manual route if it has been previously created by the pilot.
– CHD: This facility enables the pilot to skip forward from the current DWP, so the NNWP becomes the new DWP.

STEERING LAWS

The available Steering types are as follows:

– DIRECT
– TRACK ACQUIRE, which includes the following Steering modes: Route, Point To Point, Combat Air Patrol, Combat Air Patrol Acquire.
– HOLD
– NO-STEER.

Depending on the steering type and mode selected, each leg of the navigation route can be divided into the following segments:

– TURN. This is used only in CAP steering mode; the steering bug will command to null the angle between the Actual track and the Command Track (Direct Track from the A/C PP and the current DWP).
– STRAIGHT. This is the first segment of the leg and it is flown when the previous leg has been completed. The Command Track is defined as the track from the acquired waypoint to the DWP.
– DIRECT. This is the first segment of the leg in Direct Steering. The Command Track is defined as the Direct Track from the a/c position to the next waypoint updated every cycle.
– OVERFLY. This is initiated on completion of a Direct segment (i.e. when the direct range is

less or equal to 2 Nm). The Command Track is frozen to the last calculated Direct Track value and is no longer updated.

DIRECT STEERING TYPE

Direct Steering is selected automatically (if a DWP is available) when Weight off Wheels is detected or after over-flying the last waypoint in the selected route or manually, at any time, when the related Key is boxed on the LHGS DIR. In Direct steering mode, the track directly from the PP to the current DWP is continuously updated while the leg is being flown and is drawn in white on the MHDD/PA format, see Figure 1.165.

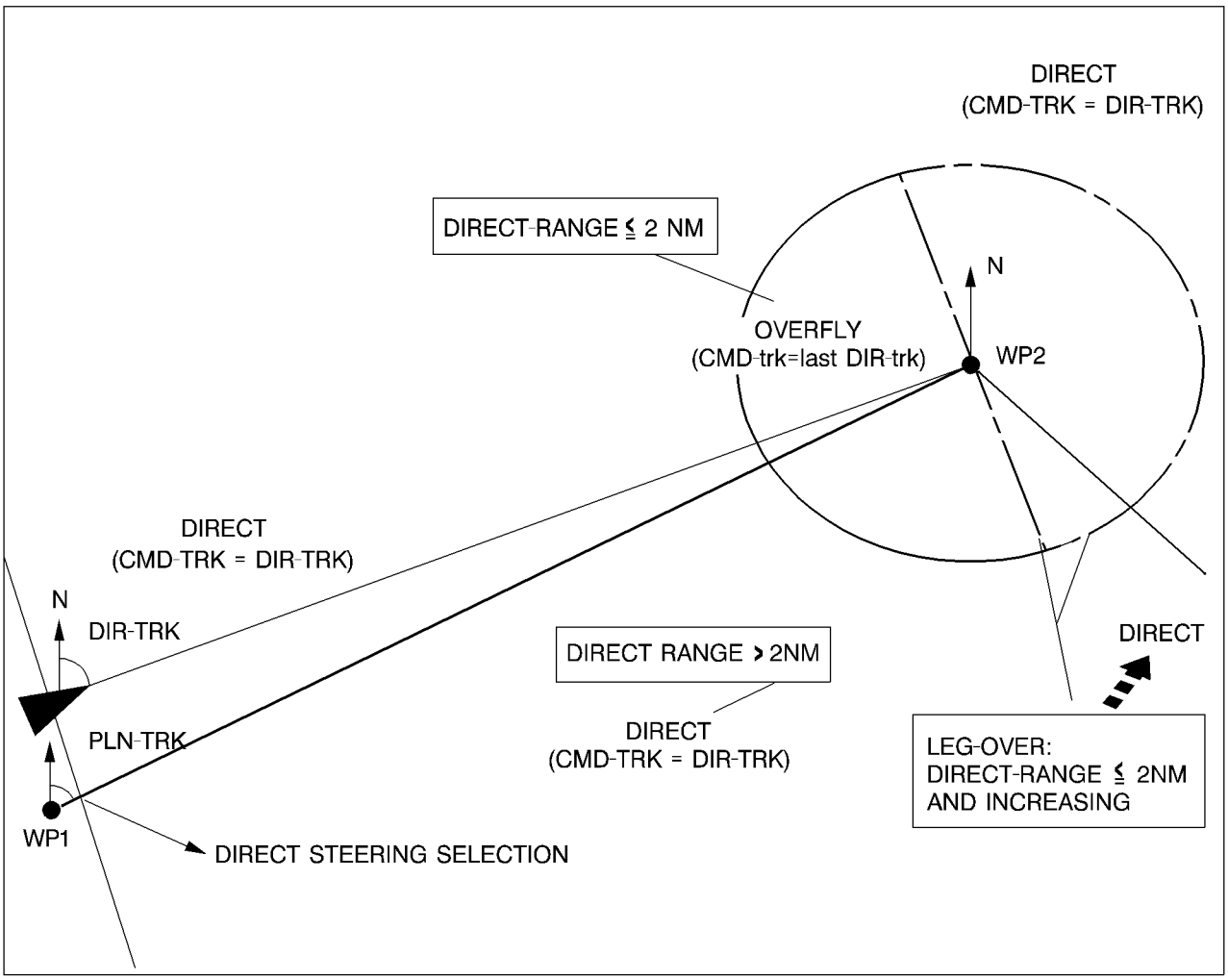


Figure 1.165 - Direct Steering Type

TRACK ACQUIRE STEERING TYPE

The Pilot can select Track Acquire Steering if required, using the TRK/DIR moding key and highlighted by pressing TRK. In Track Acquire Steering type, steering information is presented to the pilot to enable optimum tracking and re-acquisition of a Planned Track defined by the route and the steering mode engaged. The Track Acquire Steering has 4 different modes: Route, Point-To-Point, CAP-Acquire and CAP according to the WP type to be flown is Route, Overfly or CAP, see Figure 1.166 and Figure 1.167.

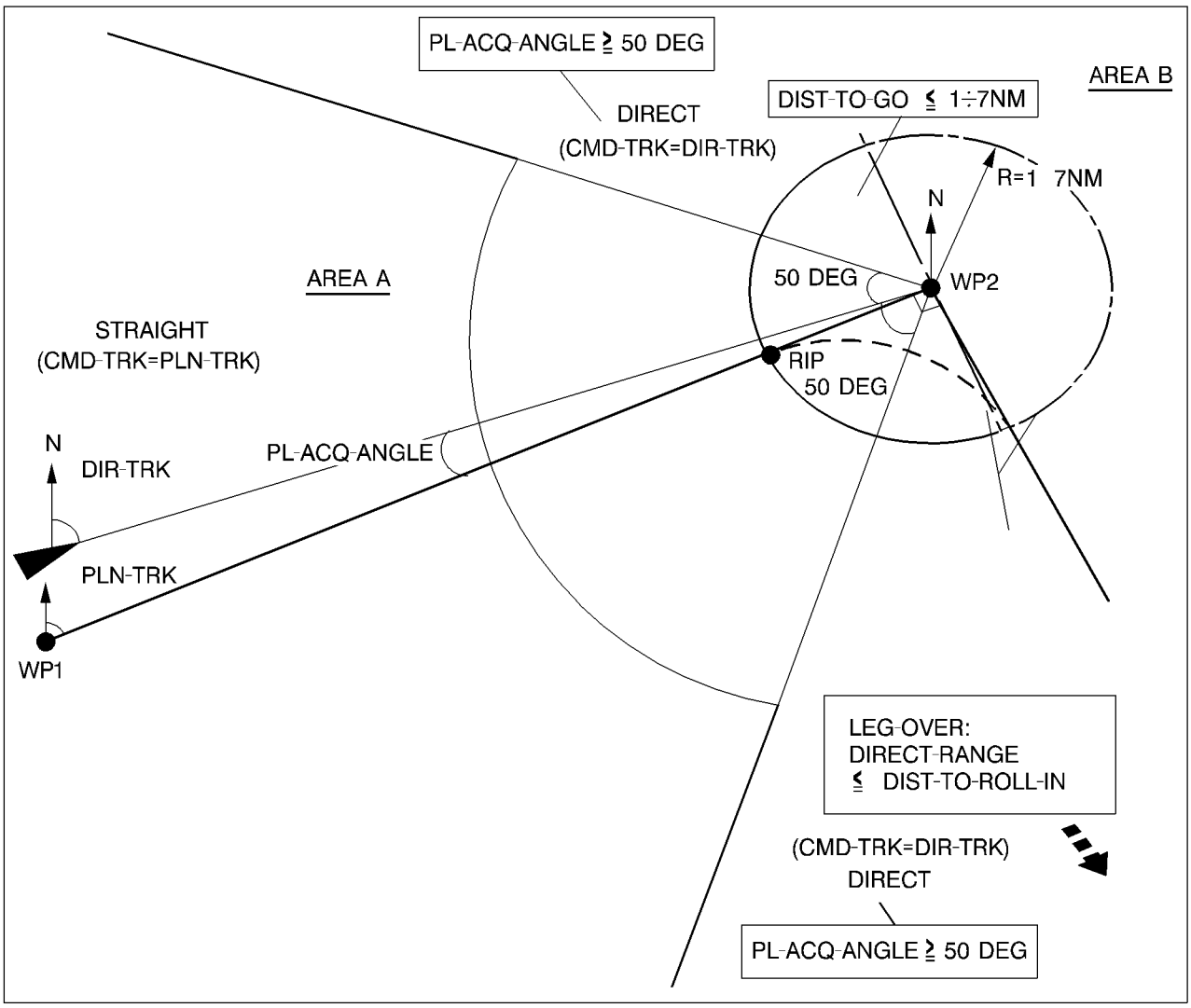


Figure 1.166 - Route Steering Mode

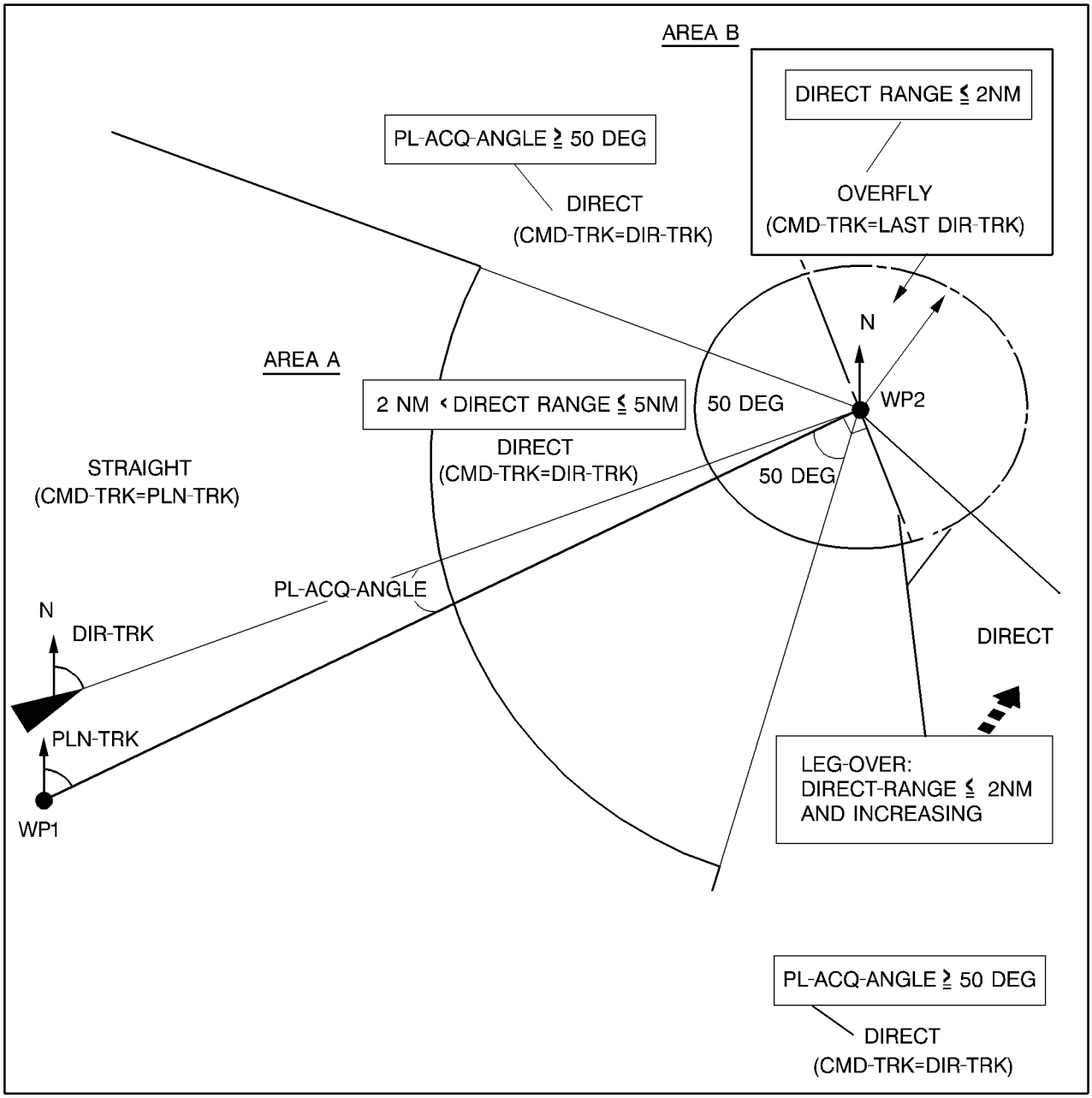


Figure 1.167 - Point To Point Steering Mode

ROUTE STEERING MODE

Steering information is provided so that a smooth transition from the current leg to the next leg is achieved without overflying the DWP. The point at which the transition is performed is named the Roll-in-point and it is the point to which the TIME-TO GO and DIST-TO-GO are calculated.
The Route Steering mode is automatically entered when the DWP is a Route.

POINT TO POINT STEERING MODE

Steering information is provided so that the DWP is overflown before the next leg is entered. This type is automatically entered when DWP is an overfly or Landing waypoint.

COMBAT AIR PATROL (CAP) STEERING

The navigation system provides steering cues to assist the pilot in acquiring and maintaining position on a pre-defined CAP pattern. At all times, the HUD and MHDD/PA format waypoint data blocks show range and bearing to CAP datum, and the MHDD/PA format displays: the CAP pattern, the CAP datum and the planned CAP speed in knots.
When approaching a DWP that has been defined as a CAP, the system provides the following different phases of navigation steering:

– CAP acquire steering: A CAP waypoint is treated initially as a route waypoint, and the navigation system uses route steering, i.e. it will initiate a turn to capture the planned track away from the DWP (the CAP datum) before reaching the waypoint itself. The start point of the turn is calculated by the system, and varies according to aircraft position, groundspeed and the bank angle to be used, which itself varies as a function of airspeed. This means that, unless the aircraft is approaching the CAP datum on the same track as the planned outbound (hot) leg, the aircraft will not overfly the CAP datum on initial capture. Once the system has reached the 'turn-in point', the system changes to CAP steering. On the MHDD/PA format, a white direct track line is drawn between the PP and the CAP datum until the turn-in point is reached. The CAP pattern is also always displayed. Once the system changes to CAP steering, the MHDD/PA format shows the hot leg drawn in bright white.
– CAP steering: This provides steering cues to capture and maintain the planned CAP pattern, using capture laws similar to those used in Track Acquire steering.
To allow flexibility in how the CAP pattern is flown (e.g. the pilot may wish to fly a very tight pattern for a low altitude visual CAP, or a slack pattern in IMC at high altitude) the navigation system continuously adjusts the size of the pattern in response to how the pilot maneuvers the aircraft. The Hot Leg (i.e. from the CAP datum, outbound on the CAP orientation track for the specified leg length) is always fixed. At the end of the hot leg (either overflown, or abeam), the steering bug will give a fly left or right command to carry out a left or right hand pattern as specified. Note that the steering bug is in bank angle demand mode (as in normal track acquire steering) and if followed accurately will turn the aircraft using a bank angle defined by aircraft speed: this bank angle is also used in calculating the expected turn radius, and thus the size of the CAP pattern drawn on the MHDD/PA format.

Note that if the pilot has turned tighter than the nominal rate when turning from hot to cold leg, the system will automatically adjust the CAP pattern size, and display the actual pattern being flown on the MHDD/PA format. The end of the cold leg is defined as when the aircraft passes abeam the CAP datum point. The steering bug then gives a turn command back towards the CAP datum: route steering is given to recapture the hot leg. This moding allows the pilot to fly the CAP pattern with whatever bank angle and maneuver rate he wishes, while still providing steering cues to capture and maintain the hot and cold legs and the MHDD/PA format always displaying the size of the actual CAP pattern he is using.

– Off CAP Steering: If the aircraft flies outside an area defined by one hot leg length all around the hot leg, CAP steering is disengaged and the system reverts to CAP acquire steering to re-position the aircraft back onto the outbound hot leg.

The CAP steering described in the previous paragraph is inhibited when the aircraft diverges by more than one CAP leg length all around the hot leg. This will usually occur when the aircraft leaves the CAP to investigate or engage a target of interest. When this occurs, the navigation system reverts to CAP acquire steering, i.e. the steering bug provides commands to steer back directly to the CAP datum, and will turn onto the beginning of the hot leg when it reaches the calculated turn-in point. The only exception to this condition is when the fighter is within a narrow cone extending from the CAP datum symmetrically about the hot leg. If the fighter is within this cone (for example, the pilot has extended beyond the end of the hot leg to investigate a track, and then turned back towards datum), then the system will provide steering direct to the CAP datum. On approaching the datum, instead of attempting a

route steering turn-back onto the hot leg before reaching the datum (which it cannot achieve because the aircraft is too close to the hot leg outbound track), the system will continue to steer to overhead the datum and will then fly a teardrop turn back onto the hot leg. If the aircraft moves from being within the cone to outside the cone, then the route steering mode will automatically be entered.

HOLD STEERING

The Command Track is frozen to the Best Actual Track at the Hold mode selection. Hold Steering mode can be selected:

– automatically at Take off (WOW transition) if the selected route does not contain any waypoints
– manually at any time by selecting the STR/ HOLD moding key.

After deselecting HOLD, the system reverts to the previously engaged steering mode and Planned Track.

NO-STEER

When the A/C is on the GND and Weight OFF Wheels has not been detected, the Steering type will be set to No-steer and only NWP, NNWP, AUTO Route and MANUAL Route information will be available to the pilot.

AUTOMATIC DESTINATION WAYPOINT CHANGE

Automatic change destination occurs for Direct Steering when the Direct-Range ≤ 2 Nm and increasing and a fixing procedure is not in progress (on the MHDD FIX OTF key is not boxed).

If Track Steering is selected and Steering mode is Point to Point, change leg will occur when Direct-Range ≤ 2 NM and increasing.

If Track Steering is selected and Steering mode is Route, change leg will occur when Direct-Range ≤ Dist-To-Roll-in.

If a fixing procedure is in progress (on the MHDD FIX OTF key is boxed) the leg completion will occur upon fix error acceptance/rejection with Direct-Range ≤ 2 NM and increasing. Steering to the fix waypoint will continue to be provided, after overflying the fix waypoint, until the fix procedure is completed.

Automatic change destination does not occur on approaching a CAP waypoint; CAP waypoints remain as DWP until the pilot manually selects CHD.

MANUAL DESTINATION WAYPOINT CHANGE

A manual facility is provided, using the CHD button on the MDEF to enable the pilot to skip forward from the current DWP.

In Track Acquire Steering, after using the change destination facility, the new Planned Track is the leg of the selected route connecting the previous DWP to the new DWP.

In Direct, steering after using the change destination facility, steering information will be relative from the PP to the DWP.

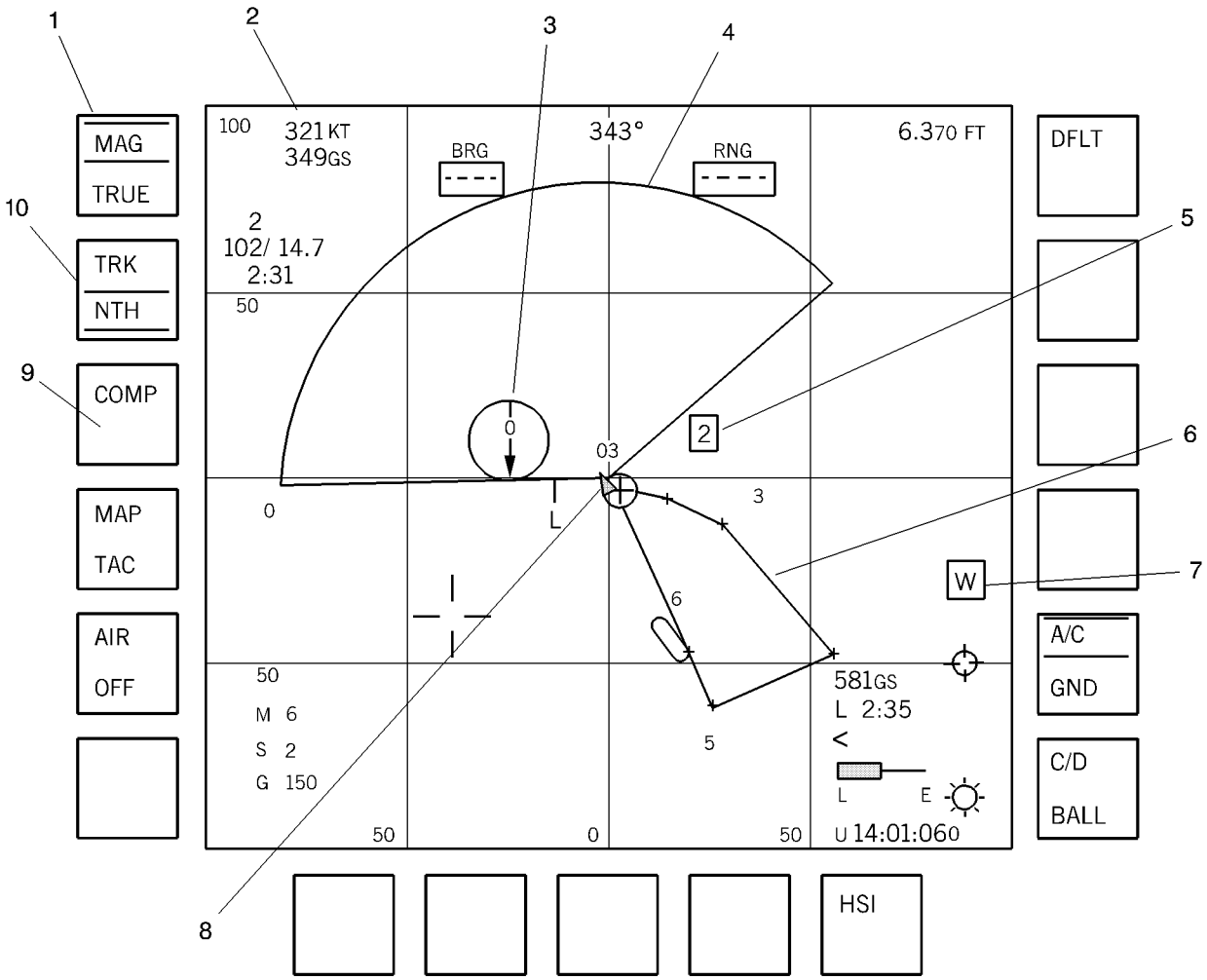
In Hold Steering, a selection of change destination will result in re-selection of the previously selected steering mode with no change to the current DWP.

NAVIGATION FORMAT DISPLAYS

The navigation format displays enable the pilot to monitor the status of the complete navigation system and moreover present a variety of navigation information to steer the aircraft during flight. The status and the navigation information is displayed on the MHDD/PA format, on the Head-Down Head Up Display (HDHUD) format and on the HUD.

MHDD Pilot Awareness Format

The MHDD Pilot Awareness (PA) format, see Figure 1.168, can be displayed to the pilot in all phases of flight (PoF).



1 MAGNETIC TRUE SELECT SOFT KEY
2 CURRENT DISPLAYED AIR SPEED/GROUND SPEED
3 WIND SPEED AND DIRECTION
4 COMPASS ROSE
5 CURRENT DESTINATION WAYPOINT
6 CURRENT AUTOROUTE LEGS
7 WINDOW ON THE WORLD ICON
8 TRIANGLE TO INDICATE SELF PP
9 COMPASS SOFT KEY
10 TRACK UP/NORTH UP SOFT KEY

Figure 1.168 - Pilot Awareness Format

The MHDD/PA and WPT formats are the main displays for navigation waypoint position and route data.

A waypoint block is shown on the MHDD/PA Format, displaying waypoint number, range and bearing and distance to go/time to go to the next waypoint and TACAN range and bearing.

The TACAN channel number and mode are also displayed on the Dedicated Readout Panel (DRP) on the right glareshield.

The selected route is displayed, with associated waypoints, with the current leg shown in white and the remainder of the route in green. In Direct steering, the current leg is shown direct from the PP to the DWP, while in Track Acquire steering it is shown as the planned track between the previous and destination waypoints. The MHDD/PA always displays the active route and its waypoints and provides a very easy and simple method to monitor the Present Position (PP) against the desired route or track.

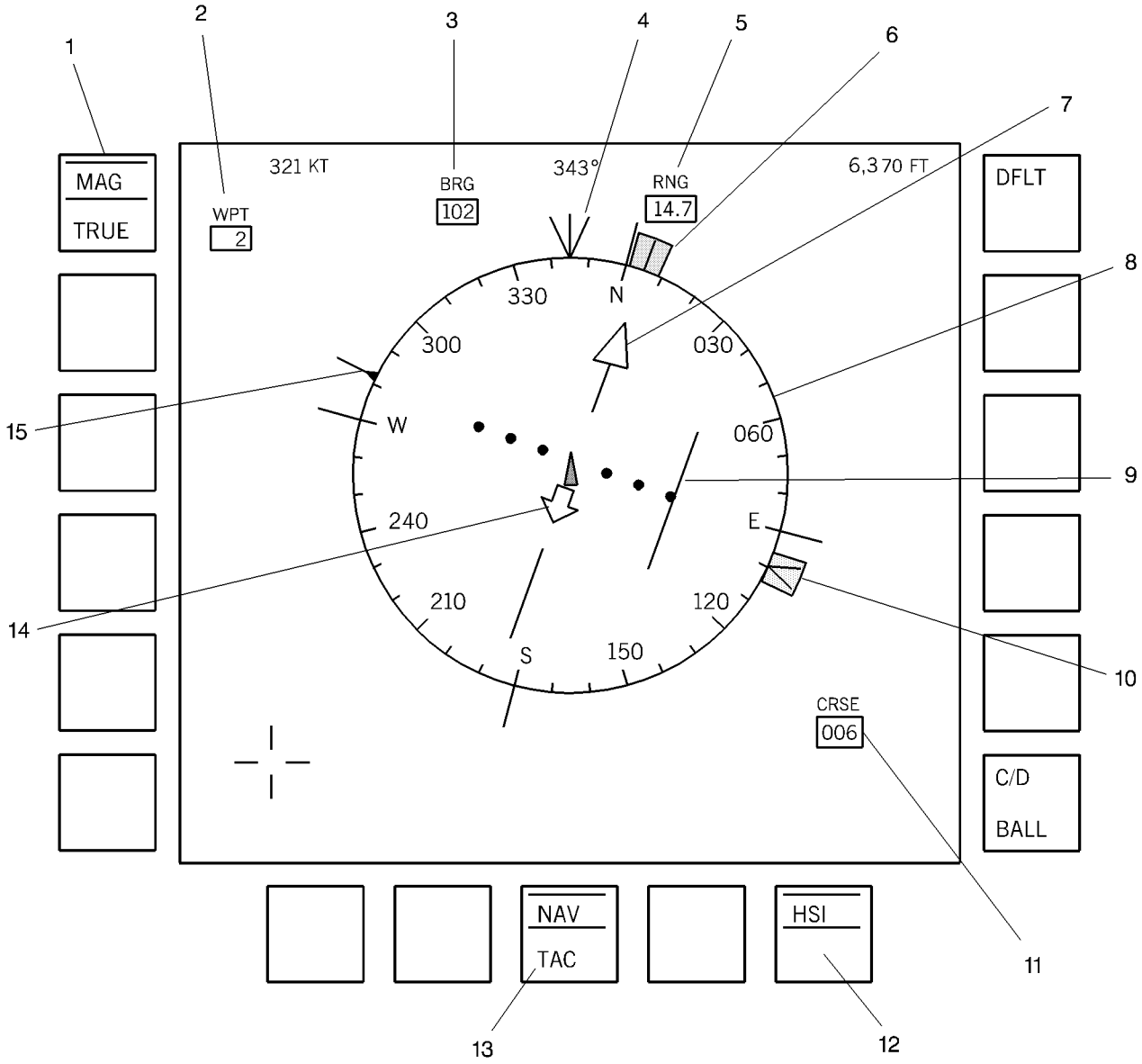
A "zoom" function is provided on the MHDD/PA format which allows the pilot to rapidly select an expanded area of the main display. Zoom is selected by an XY insert, pressed for more than 1 second, on the required point. Zoom is cancelled by a short XY insert on a blank space.

The MHDD/PA format also provides the basic Navigation display setting functions:

– Compass Rose - A compass rose is superimposed on the MHDD/PA format to provide a heading reference. Either a 360°, partial (120°) rose or none can be displayed by pressing the COMP soft key on the MHDD/PA format.

  Magnetic/True Orientation - All heading references on the HUD and MHDDs can be set to either true or magnetic by pressing the MAG/ TRUE soft key on the MHDD/PA format. The default orientation on power-up is "Magnetic". Note that if the HSI is selected with TACAN as the HSI navigation data source, the aircraft heading references are automatically set to Magnetic.

– Horizontal Situation Indicator (HSI) - A conventional HSI type display presentation is provided, selected by HSI soft key on the MHDD/PA format, see Figure 1.169.

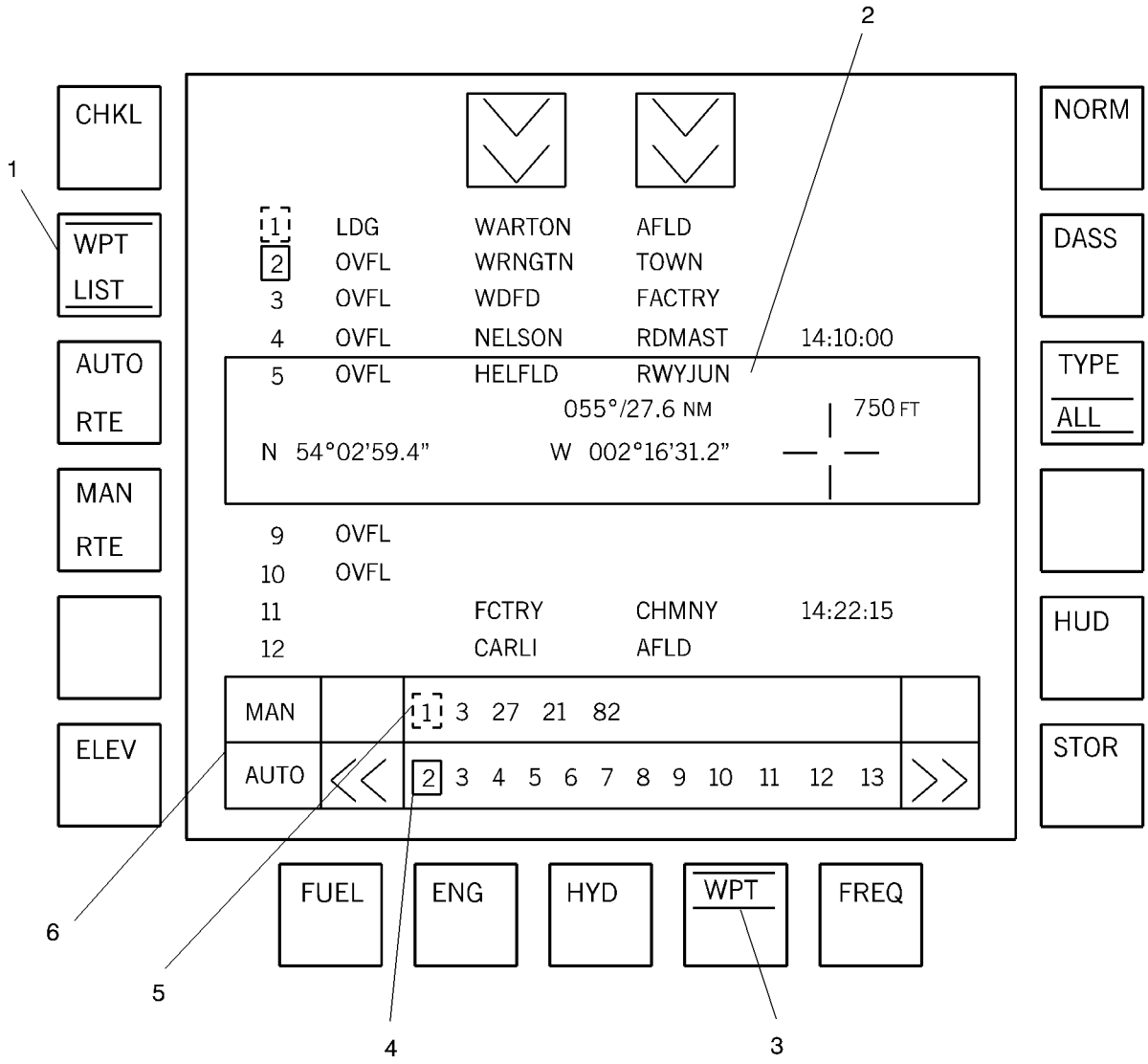


1 MAGNETIC/TRUE SOFT KEY
2 DESTINATION WAYPOINT
3 DIGITAL BEARING DISPLAY
4 LUBBER LINE WITH CURRENT TRACK SYMBOL "V" SUPERIMPOSED
5 DIGITAL RANGE DISPLAY
6 HEADING BUG
7 COURSE POINTER
8 COMPASS ROSE
9 LATERAL DEVIATION BAR
10 TAIL OF THE DIRECT POINTER
11 DIGITAL COURSE DISPLAY
12 HSI SELECT SOFT KEY
13 NAV/TAC SOFT KEY, NAV SELECTED
14 TO/FROM FLAG
15 POINTER-DIRECT BEARING TO WAYPOINT (NAV) OR BEACON (TAC)

Figure 1.169 - HSI format

Waypoint Format

The Waypoint format is selected using the WPT soft key which is available on most RMHDD formats. A typical waypoint list format is shown in Figure 1.170.



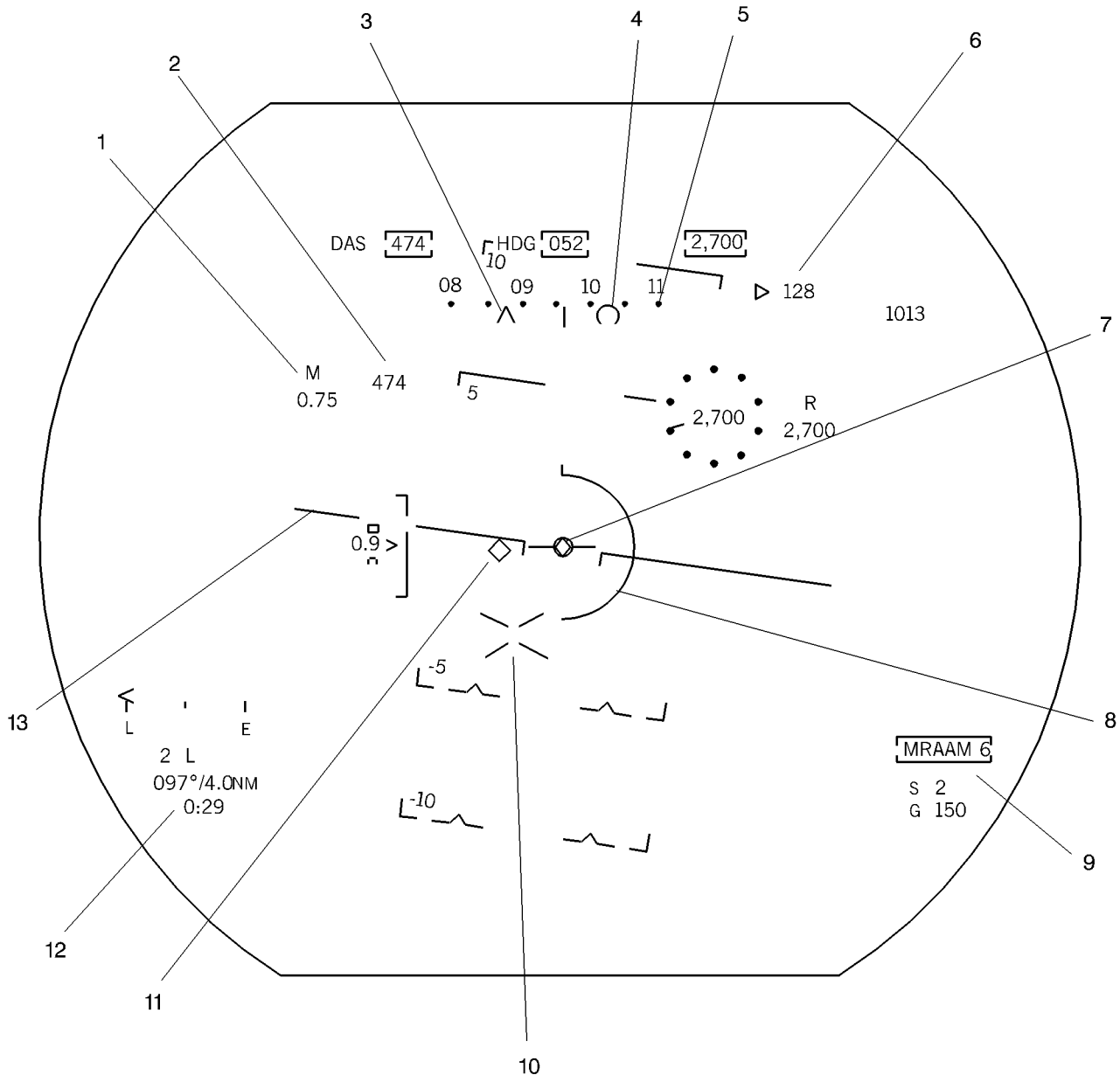
1 WPT LIST SOFT KEY
2 WAYPOINT EXPANDED INFORMATION BOX
3 WPT SOFT KEY
4 CURRENT DWP HIGHLIGHTED
5 NON-ACTIVE ROUTE JOIN WAYPOINT (JWP)
6 AUTO AND MANUAL ROUTE ROLS

Figure 1.170 - Waypoints Format with Extra Information

It provides a list of the waypoints within the Navigation system by number and provides details of the waypoint type, identifier, a simple description and, if defined, the planned time of arrival. An XY insert anywhere on the waypoint data line opens an expanded information box detailing waypoint number, lat/long, direct range and bearing to the waypoint from the PP, waypoint elevation and planned altitude (if defined). The Waypoint format also displays the waypoints in the Auto or Manual routes. These show the route waypoints in order, the join and destination waypoints for each route. The active route ROL shows the current route, with the current DWP highlighted in the first position in the ROL and also on the waypoint list.

Head Up Display (HUD)

The Head Up Display, see Figure 1.171, presents a variety of navigation information to steer the aircraft.



1 MACH OR GROUND SPEED DISPLAY
2 DAS DISPLAYED
3 CURRENT TRACK
4 STEERING BUG
5 HEADING RIBBON
6 NEXT TRACK AND DIRECTION OF TURN ARROW
7 AIRCRAFT SIMBOL
8 TIME TO-GO TO OVERFLY WAYPOINT
9 WEAPON STATUS BLOCK
10 WAYPOINT CROSS
11 VELOCITY VECTOR DIAMOND
12 WAYPOINT DATA BLOCK
13 ZERO DEGREE HORIZON BAR

Figure 1.171 - HUD Navigation Format

– The Navigation data block shows: waypoint number and type, direct range and bearing, time to go to overhead
– The Steering cue provides the required guidance to capture or maintain the required track.

In all phases, the Steering Cue command is limited by a simple schedule based on Calibrated Airspeed to ensure that the bank angle limit will allow maximum turning performance, avoiding an undesirable flight condition (e.g. buffet, stall, etc.).

CLOSE NAVIGATION

Close Navigation phase is engaged when Time to go ≤ 65 seconds and includes the Time to go circle (counting down from 65 seconds), the waypoint cross (indicating the computed waypoint position in terms of azimuth and elevation), an indication of the next planned track and the direction to turn to achieve it.

STEERING SELECTION

The pilot can select either route (AUTO/MAN route) for steering using the LHGS NAV SS key. The AUTO route is the default route (if available), if no other selection has been made, otherwise HOLD mode is engaged. During the GND Pof, only the NWP and NNWP are initialized, if they are part of a route.

Following a Weight OFF Wheels transition, the other steering parameters (Distance to go, Time to go steering mode, scheduled time enabled, etc.) are also calculated. The system will automatically change from one DWP to the next in the selected route according to the criteria of the Steering Law.

When Track Acquire Steering is selected and the DWP is OVERFLY, the following segments will be engaged:

– Straight. This is the first segment of the leg and is initiated when the previous leg has been completed. The Command Track is defined as the Planned Track from the recently acquired WP position to the NWP and will not be updated.
– Direct. This is initiated after the Straight segment when Direct Range ≤ 5 NM or Planned Acquire Angle ≥ ± 50° (dependent upon the ratio between the Across Track Distance and the Distance Along Track). During the Direct segment, the Command Track will be defined as the Direct Track from the A/C position to the NWP.
– Overfly. This is initiated after the Direct segment when Direct Range ≤ 2 NM. During the Overfly segment the Command Track is frozen to the last calculated Direct Track value and is no longer updated.

When Track Acquire Steering is selected and the DWP is ROUTE the following segment will be engaged:

– Straight. This is the segment of the current leg unless the Planned Acquire Angle > ± 50° (dependent upon the ratio between the Across Track Distance and the Distance Along Track in this case the DIRECT segment will be engaged. For the turn manoeuvre, the system can operate in two different modes:

  * Turn Radius Constant. With this option, the bank limit used for the computation of the RIP and required during the turn manoeuvre is that which achieves a constant turn radius of 2.5 NM. However, when the bank required for the constant turn radius is greater than 60° or the altitude is greater than 20 000 ft, the turn radius will become variable and the RIP will be calculated.
  * Turn Radius Variable. The bank angle limit demand depends on the CAS and ranges from 30° to 60°. Consequently, the resulting turn radius of the manoeuvre for the new leg acquisition will vary with groundspeed and altitude.

If Direct Steering is selected, the following segments will be engaged:

– Direct. This is the first segment of the leg. During the Direct segment the Command Track will be defined as the Direct Track from the A/C position to the NWP.
– Overfly. This is initiated after the Direct segment when Direct Range ≤ 2 NM. During the Overfly segment the Command Track is frozen to the last calculated Direct Track value and is no longer updated.

In Direct Steering the ROUTE Waypoint is considered as an OVERFLY Waypoint as well.

STEERING BUG CALCULATIONS

The steering azimuth commands to acquire and hold the planned track are calculated and displayed as a steering bug below the A/C heading ribbon as a displacement from the HUD azimuth centre line for manual steering by the pilot and on MHDD HD/HUD format. The steering bug provides azimuth guidance, based on the calculation of a non-linear function of the error between the rate limited bank angle demand and the actual bank angle. The demanded bank angle is calculated according to an algorithm that takes into account FCS CAS data, align mode type, current phase of flight and steering type, with a limit value of 60°.

In order to acquire or re-acquire the Command Track, the basic steering bug laws are:

– INTERCEPT phase, which aims to take the A/C to cross the Planned Track with a fixed value of 50°. The condition for entry to this law is the invalidity entry condition for the following two laws.
– ACQUIRE phase, which aims to direct the A/C into a nominally fixed bank angle turn such that the circular arc turn would be tangential to the Planned Track. The condition for entry to this law depends on a continually evaluated across track distance threshold value and the difference between the planned track angle and the A/C track angle.
– CAPTURE phase, which aims to direct and maintain the A/C onto the planned track. The condition for entry to this law depends on a continuously evaluated turn rate less than a demanded turn rate and the difference between the planned track angle and the A/C track angle.

If the steering type is DIRECT the Steering-Bug Drive is set equal to the Heading Error.

Navigation Modes

(1B-B-34-63-00-00A-043A-A Issue 005)

The Navigation System automatically selects the best available navigation mode from the combination of available sensors. The pilot can manually override the system by selecting one of the Navigation modes available on selection of NAV MODE MK with the AIDS SSK on MDEF.

Six navigation modes, which allow a graceful degradation in performance, are available.

The Navigation System operates in six modes in decreasing order of accuracy:

NAV mode	Sensors	NAV mode cockpit indication
1	LINS + KF + GPS	LINS GPS1
3	LINS + KF + OTF	LINS FIX1
4	LINS + GPS	LINS GPS2
5	LINS + OTF last + KF correction	LINS FIX2
6	FCS + GPS	FCS GPS
8	FCS + OTF	FCS FIX

NOTE

The Navigation System, in the event of a total failure of the NAV sensors, includes Get-You-Home (GUH) instruments.

Automatic Selection of Navigation Mode

Normally the system selects and operates NAV Mode 1 (LINS GPS1) and no fixing is required to be carried out by the pilot (refer to Figure 1.172).

If the LINS data are valid, the GPS data are not valid (GPS unhealthy or FOM greater than 4 or position/ velocity covariances exceed specified threshold) and KF is available, the NC KF calculates the Best Present Position Error estimate. If this value exceeds the established threshold, the Navigation System automatically selects NAV Mode 3 (LINS FIX1), otherwise NAV Mode 1 is maintained.

If LINS and GPS data are valid but KF is unavailable, the Navigation System automatically enters NAV Mode 4 (LINS GPS2).

If last entered mode was 4 and GPS data become invalid for less than 90 sec, NAV Mode 4 is maintained, otherwise the Navigation System enters NAV Mode 5 (LINS FIX2).

If LINS data are invalid, FCS and GPS data are valid, the system automatically enters NAV Mode 6 (FCS GPS).

If last entered mode was 6 and GPS data have been invalid for less than 90 sec, NAV Mode 6 is maintained, otherwise Navigation System enters NAV Mode 8 (FCS FIX).

If LINS and FCS are both invalid, then no NAV Mode is available.

Manual Selection of Navigation Mode

The pilot may select any navigation mode at any time provided that sensor availability will support that mode.

Modes 3 (LINS FIX1), 4 (LINS GPS) and 5 (LINS FIX2) are all available when the LINS is available. If the LINS is unavailable then the navigation system uses a secondary dead reckoning function based on air data and the IMU data from the FCS.

Reversionary navigation modes based upon the FCS sensors are Mode 6 (FCS GPS) and Mode 8 (FCS FIX).

Mode 6 (FCS GPS boxed on LHGS) is based upon FCS data corrected by automatic fixing using the GPS sensor. Mode 8 (FCS FIX boxed on LHGS) is based upon FCS data but corrected by a manual fixing procedure (On Top Fixing, OTF).

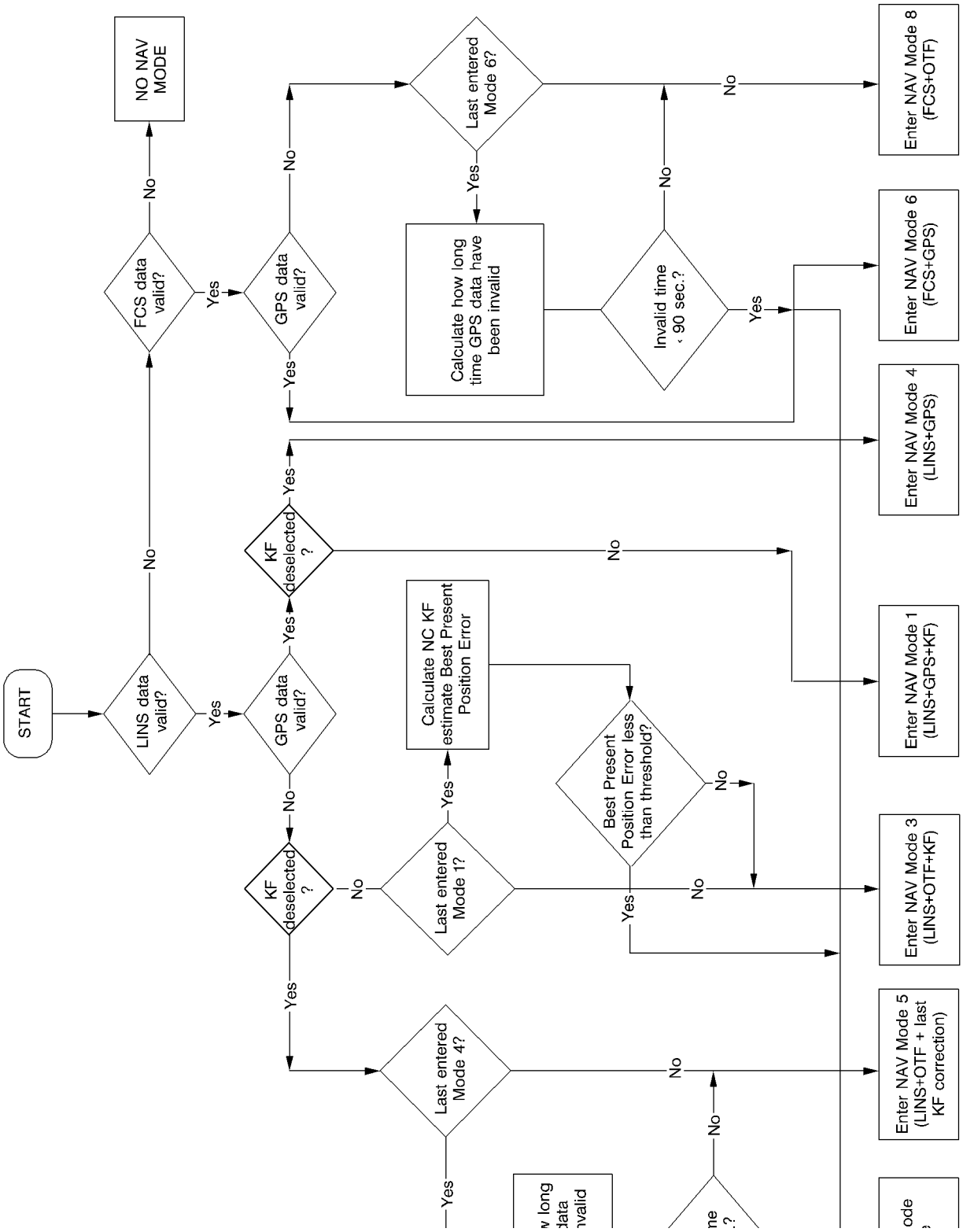


Figure 1.172 - Navigation Auto Mode Logic

Laser Inertial Navigator System (LINS)

(1B-B-34-41-00-00A-043A-A Issue 005)

The main purpose of the Laser Inertial Navigation System (LINS) is to provide the primary source of information for navigation parameters:

- Present Position (LAT, LONG)
- True Heading
- Magnetic Heading
- Bank
- Inclination
- Climb/Dive Angle
- Velocities
- Body Angular Rates
- Baro-IN Altitude
- Accelerations.

Modes of Operation

The LINS sends/receives its output/input information by means of a dual redundant digital Data Bus. It operates as a Remote Terminal on the Attack Bus.
The LINS is activated as soon as AC and DC power are available. When the LINS is energized, it performs a Power-Up BIT (about 10 seconds). After successful completion of the Power-Up BIT, the LINS automatically enters the Normal Alignment mode (gyrocompass) using the stored Present Position (PP), it is not entered by pilot.
The LINS requires accurate initial position data and standard baro altitude from FCS to stabilize its vertical channel.
The LINS alignment status is displayed on the MHDD/ACUE format and HUD, and is shown in terms of the LINS position drift in nautical miles per hour (CEP) and time to go to alignment completion.
As the alignment progresses the displayed position error decreases, starting from 64 Nm/h; when the specified acceptable performance level is attained, a "LINS READY" caption is displayed on the ACUE format and HUD. When the Alignment is completed (with full performance, i.e. 0.8 Nm/h), the pilot can select the LINS Navigation mode manually by setting the relevant soft key NAV SEL on the MHDD, or automatically on aircraft movement.

Alignment Modes

After successful completion of the Power-Up BIT, the LINS automatically enters the Normal Alignment mode (gyrocompass). Selection of a particular alignment mode is made either by an input from PDS or GLU which provides an automatic trigger to the system, or by a manual selection of a soft key on the Autocue format. Three alignment modes are available on PoF "GND":

- Normal/Full Gyrocompass Alignment
- Memorized Heading Alignment
- Rapid Heading Alignment.

Moreover three additional functionalities take into account the various operative conditions in which the alignment can occur:

- Alignment Refinement
- Incremental Alignment
- Alignment Restart.

Normal/Full Gyrocompass Alignment

The Normal Alignment mode is used when the reaction time is not critical. It is an automatic self-contained process to determine Local Vertical and Heading. When the LINS normal alignment is initiated, and the PDS or GLU data is unavailable, PP must be manually entered via the MDEF (AIDS - PP - DEK). If the local PP is not entered, the LINS will use the last stored Present Position (PP) and the Alignment Error on Autocue format will be stopped at 4 Nm/h, the output IN-Present Position-Dval will be set Invalid as a safety measure and the equipment will not be used for navigation purpose.

LINS needs the Standard Baro Altitude input valid from FCS in order to stabilize its vertical channel. If the Standard Baro Altitude becomes invalid for more than 5 minutes, LINS will declare the vertical channel invalid (i.e. LINS navigation modes are lost).

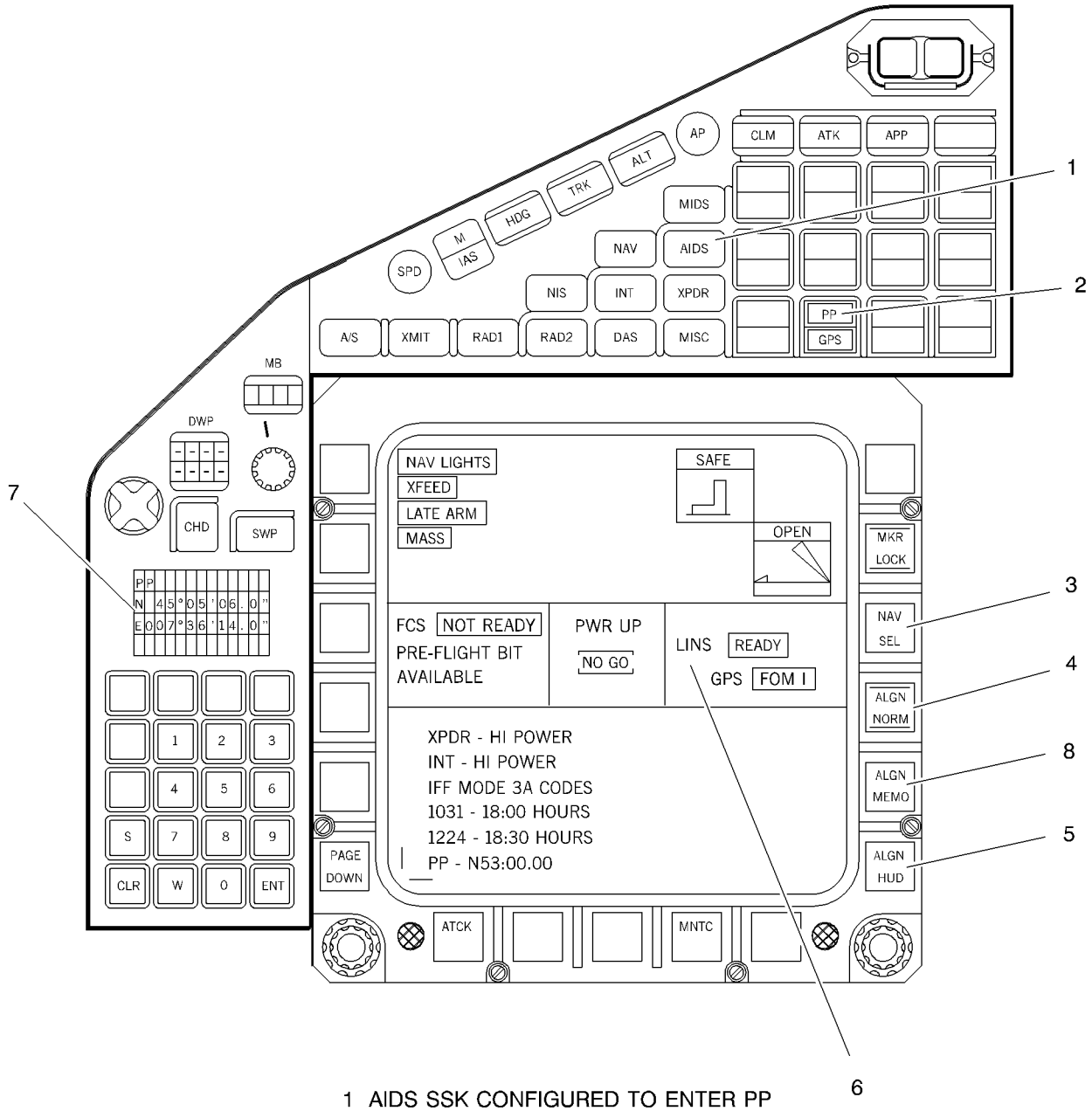
When the Standard Baro Altitude is valid again, LINS will reacquire its vertical channel within 90 sec.

NOTE

Each time a gyrocompass alignment is required to the LINS, the Present Position must be entered by the pilot even if it is the same position on which the LINS is aligning, otherwise NAV ALIGN Status will not reach the value of 0.8 NM and lat/long will be set INVALID by the LINS (i.e. LINS navigation modes are not available).

The pilot can enter aircraft Present Position (PP) only with weight-on-wheels and Phase of Flight (PoF) GND.

During this procedure the data related to LINS alignment are available: PP on which LINS is aligning is displayed on Manual Data Entry Facility Read Out Lines (MDEF ROLs) and LINS accuracy error and time to NAV ready are displayed on MHDD Autocue Format (see Figure 1.173).



1 AIDS SSK CONFIGURED TO ENTER PP
2 PP SOFT KEY
3 LINS NAV/ALIGN MODE SELECT KEY
4 ALIGN NORM SOFT KEY
5 HUD ALIGNMENT SOFT KEY
6 LINS STATUS
7 ROLS FOR PP DATA INPUT
8 ALIGN MEMO SOFT KEY

Figure 1.173 - MHDD Autocue Format - LINS Alignment

Ensure that the "ALIGN" indication and "ALGN NORM" soft key is illuminated on the Autocue format. Within 240 seconds verify the "LINS READY" indication is present and at least one of the LINS NAV modes is available. The LINS automatically enters Navigate mode on aircraft movement or by pilot selection pressing the NAV SEL soft key.

Memorized Heading Alignment

The Memorized Heading Alignment mode is used when the reaction time is critical. It makes use of the last recorded values of present position and heading. This Memorized Heading selection will be made available if the following OFF mode procedure is followed:

– a full Gyrocompass Alignment has been performed without entering NAV Mode
– remove AC power and 1 minute later, DC power
– the aircraft has not been moved from the last OFF-Mode.

To perform memo HDG, press "ALGN-MEMO" soft key on the Autocue format, or command it via PDS/ GLU. After 30 seconds "LINS READY" is displayed.

RAPID Heading Alignment (HUD)

This alignment type requires an accurate PP and bearing or coordinates of a reference optical object. These data are provided by PDS/GLU to the system. The pilot initiates HUD alignment by means of the XY controller. He has to point at the reference object and then to press the XY controller in order to start the alignment. As soon as the XY controller is moved ALGN HUD is boxed (ALGN NORM lit but not boxed).
The Navigation Computer provides to the LINS the current heading, derived from PP and bearing/ coordinates of a reference point. Heading Offset between reference point and the aircraft will be provided by placing the XY marker (on HUD) on reference point and pressing the XY Controller.
After 30 seconds "LINS READY" is displayed.

Alignment Refinement

Alignment Refinement occurs when an alignment is completed successfully (LINS error ≤0.8 Nm/h), the navigation time does not exceed 10 minutes and the aircraft does not exceed a velocity of 50 knots and Weight-On-Wheels is set to on. When steady pulling the PARK BRAKE, the refinement will be performed to obtain the best possible alignment before take off.

Incremental Alignment

During Alignment phase, in case LINS enters Navigate Mode (either manually or via automatic navigation mode selection ANMS) with TIME-TO-NAV less than 150 seconds and the navigation time does not exceed 10 minutes and the aircraft does not exceed a velocity of 50 Knots and Weight-On-Wheels is set on. The pilot is able to exit navigate state and continue alignment by pulling the PARK BRAKE.

Alignment Restart

LINS will be capable to perform a new alignment (full gyrocompass). To do this, the following procedure has to be followed:
Before Take Off:
1 PARK BRK in ON position
2 LINS in navigate state, NAV SEL boxed on Autocue format
3 LINS time to NAV Ready is greater than 149 seconds, on HUD and HDHUD
4 NAV SEL press on Autocue format
5 Enter local Initial Position (IP) within 45 seconds
6 LINS will align on the new IP just entered
7 In case IP is not entered and GPS is available, LINS will align on GPS position, commanded by navigation computer.
8 In case GPS is not available, LINS will align using the PP stored in the Navigation Computer.

NOTE

Alignment restart performed using IP coming from GPS or NC is to be used in emergency conditions.

Failure of LINS

The pilot is immediately alerted by flashing Attention Getters and a flashing amber "LINS" caption on the DWP. An Attention (Cat. 3) and voice warning message "LINS" is also provided to the pilot.
In case of LINS failure the system will engage reversionary navigation modes FCS GPS or FCS FIX.

Navigation Computer

(1B-B-34-64-00-00A-043A-A Issue 005)

The Navigation Computer (NC) is part of Navigation System. Its main purpose is to compute the best navigation data depending on the selected navigation mode. It also computes the navigation steering parameters and general navigation data.
The NC also manages and controls the Avionic and Attack Serial Digital data buses (EFABUS), acting as primary Bus Controller for the Avionic databus (AVS) and as reversionary Bus Controller for the Attack databus (ATK).
Two software packages are contained within the NC: the Supplier Provided Software (SPSW) which allows to access to NC hardware and the Purchaser

Provided Software (PPSW) which utilitizes the SPSW to provide the LRI functionality. The main functionalities covered by PPSW are:

- Primary and Secondary Dead Reckoning
- Navigation Steering
- Steering-Bug Calculation
- Navigation Fixing (OTF)
- Best Navigation Mode
- LINS Velocities and Position Integrity / Attitude Monitoring
- GPS Integrity
- Generation of Navigation Parameters
- Magnetic Heading Calculation
- Low Height Warning
- LINS In-flight Alignment (IFA)
- Route Loading and Manipulation
- EFABUS Bus Controller
- Bus RTs Health Status Monitoring
- Universal Time Coordinate (UTC) Management
- Input/Output
- Mission Data Loading
- Non-Volatile Memory (NVM) retrieval
- Master/Slave Management
- Initiated BIT (IBIT)
- Software Loading via Ground Loading Unit (GLU).

In normal mode of operation, the NC performs the AVS bus LRIs Health monitoring in order to provide information for bus LRIs NOGO generation, Master/ Slave management of redundant LRIs (CIU, CSG, SCAC, NSCAC), LRIs IBIT monitoring and to synchronize all the system databuses. When the NC operates in reversionary mode it also performs the ATK bus LRIs Health and IBIT monitoring.
If the NC fails as Bus Controller for the Avionic bus, the bus controlling functions are taken over by the Attack Computer. If the AC fails as Bus Controller on the Attack bus, the bus controlling functions are taken over by the Navigation Computer.
The Navigation Computer has also the capability to hand over the BC function to the GLU (via vector word protocol) when loading multimission data.
The Attack Computer and the Navigation Computer are identical from a hardware point of view, here after called the Attack/Navigation Computers (AC/ NC).
The Navigation Computer is powered from 115V AC XP busbar.

Global Positioning System Upgradeable

(1B-B-34-51-00-00A-043A-A Issue 005)

The purpose of the Global Positioning System Upgradable (GPSU) is to provide the following navigation functions: Present Position, Altitude, Earth Referenced Velocities (north, east, vertical), UTC Time and Climb/Dive Angles; Output Data Validity and Time Tags.
All the above navigational functions are derived from the reception of signals and codes transmitted by the NAVSTAR constellation which provides a world wide service.
The RF signal, codes and messages transmitted by the NAVSTAR Constellation and received by the Antenna Set (ASS for Single Seater or AST for Twin Seater Aircraft Version) are passed from the ASS (or AST) to the Antenna Electronic Unit (AEU) through seven coaxial cables. The Navigation System Unit (NSU)/AEU RF interface allows the NSU to receive RF signals on both the L1 (1575.42 ±10.23 MHz) and the L2 (1227.60 ±10.23 MHz) frequencies. The C/A-code (non-encrypted code) is available to all users of GPS and is transmitted only on the L1 frequency. The P(Y)code (encrypted code) is protected from spoofing and is transmitted on both the L1 and L2 frequencies) and includes the NAV Messages transmitted by the NAVSTAR Constellation.
External Aiding data coming from either or both the FCS and LINS is provided to the NSU to enhance the GPS acquisition/re-acquisition performance.
The GPSU consists of the following LRIs:

- Navigation System Unit
- Antenna Electronic Unit
- Antenna Set
- Mounting rack (MR) for the NSU
- Antenna set gasket.

The NSU includes a GPS Receiver embedded in a single module. The NSU GPS module is capable of providing either the Precise Positioning Service (PPS; using P(Y)-code) or the Standard Positioning Service (SPS; using the C/A-code) performance when provided with satellite signals.
The GPS Module is also able to provide the following functionality:

- Selection and acquisition of the GPS navigation signals on both at L1 and L2 frequencies using the C/A code first and then the P(Y) Code or acquiring directly the P(Y) Code
- Track the acquired navigation signals on both the L1 and L2 Frequencies
- Discriminate between wanted signals and unwanted multipath frequency effects
- Operate in adverse jamming and spoofing environments.
- Track the Anti-Spoofing (AS) codes
- Perform Integrity Monitoring functionality (RAIM or equivalent) using satellite and aircraft data which is capable of increasing the integrity of the GPS module outputs and protects them against spoofing
- Output the operational status and provide navigation accuracy estimates

- Output the Covariance Matrix for Position and Velocity
- GPS performance is not adversely affected by the GPS Week Number Rollover
- A reprogramming mode also allows SW reloads without having to remove the GPS module from the NSU
- Provide self-test features and accepts and executes an external test command
- Accept aiding data from the FCS and LINS
- Compute the position, velocity and time
- Demodulate and make use of the 50 Hz Navigation Message received by the NAVSTAR constellation.

The NSU also outputs to the EFABus, the Channel Status message related to what satellites have been acquired/tracked by each GPS Channel including the L1 or L2 frequencies, (C/A or P(Y)), the hardware channel number, the Channel Fault, the Satellite number, the Carrier/Noise and the Jammer/Signal value. The NSU is also capable of outputting a flag that declares when 4 or less than 4 satellites are tracked.
The Time to First Fix (TTFF) is defined as the elapsed time from the application of power to the GPS until the subsequent output of present position, velocity and time to the EFABus. The TTFF performance is ensured when the current almanac and cryptovariable codes are available within the GPS module (an exception is made for TTFF Search The Sky); applicable conditions are the following:

TTFF1 (acquisition via C/A Code)

- Initial three sigma position uncertainty does not exceed 100 Km
- Three sigma velocity uncertainty does not exceed 150 m/s
- One sigma initial time uncertainty does not exceed 20 seconds
- Maximum vehicle acceleration is 10 m/s^2
- Maximum vehicle jerk is 100 m/s^3
- Current almanac is available in the NSU
- A J/S of 24 dB for the C/A Code (Jamming is noise source).

The TTFF1 shall be minimized and does not exceed 5 minutes maximum time allowed with a probability of success of at least 0.9 for the conditions stated above.

TTFF2 (Direct P(Y)-Code Acquisition)

- Initial three sigma position uncertainty does not exceed 10 Km
- Velocity uncertainty is negligible
- One sigma time uncertainty due to "hardware" initialization does not exceed 10 μs
- Vehicle acceleration and jerk negligible
- Current almanac is available in the NSU
- A J/S of 30 dB for the P Code.

The TTFF2 does not exceed 4 minutes maximum time allowed with a probability of success of at least 0,9 for the condition stated above (when the GPS module has been loaded through the PTTI interface with an UTC time having an accuracy better than 10 μs).
The GPS module automatically enters the Search-The-Sky (STS) mode when the GPS module does not contain current almanac data or the internal clock is not available. Whenever the GPS module enters the STS mode, the NSU inputs the last stored present position into the GPS module. The TTFF for STS is minimized and does not exceed 20 minutes maximum time allowed with a probability of success of at least 0.9 for the conditions stated above.
Initial satellite acquisition is accomplished by one of the following methods:

- Normal Start. It is initiated whenever the receiver has current almanac data resident in memory and the initial uncertainties in PVT estimate are such that the satellite acquisition process must proceed first with C/A code acquisition and track followed by a hand-over to P(Y)-code acquisition. When the current almanac is available, then the initial uncertainties in the PVT estimates shall be those for TTFF1.
- Cold Start. It shall be initiated whenever the receiver's non volatile memory has been cleared. Satellites shall be acquired by means of a "search-the sky" technique. Satellite acquisition shall proceed first with C/A code acquisition and track followed by a hand-over to P(Y)-code signal. The initial uncertainties in the PVT estimates shall be those for search-the-sky.
- Hot Start. It shall be initiated whenever the receiver has current ephemeris or almanac data and the initial PVT estimates will enable the Direct P (Y) Code Acquisition without first acquiring the C/A Code. The current ephemeris and almanac data shall be available in the Non Volatile Memories and initial uncertainty in PVT estimates shall be those for TTFF2.

PBIT

After equipment is switched on i.e. main power applied to the Equipment, and before entering the normal operational mode, the NSU shall automatically perform a Power-up BIT. This BIT shall provide the highest possible testing of the serviceability of the Equipment compatible with the time allocated to the PBIT. During Power-up BIT the Equipment shall not generate any output and the busy bit in the status word shall be set. The NSU PBIT shall comprise at least the following tests:

– CPU check
– RAM check (non destructive) including Flash memory check
– Critical memory check (non destructive)
– Program memory check
– Check of peripheral chips
– NSU/AEU DL check
– I/O checks including the STANAG 3910 and discrete interface
– GPS Module Test
– RF section check
– Battery voltage check
– PPS-SM and AOC status check
– AEU Status.

The time allowed to perform the PBIT shall be 12 seconds max time including the AEU BIT time.

Radar Altimeter

(1B-B-34-42-00-00A-043A-A Issue 004)

General

The Radar Altimeter integrated into the Navigation System provides height above ground information for any type of terrain currently overflown, up to a maximum of 5000 ft., with a measurement accuracy of 2% of the measured height or 2 ft (whichever is greater).
It consists of:

– a transmitter/receiver
– a transmitter antenna
– a receiver antenna.

Height information, routed through the AVS data bus, is displayed on the HUD and on the MHDD/ HDHUD format (refer to Figure 1.174).
The radar altimeter clearance height setting control and display select and indicate the low height datum, respectively.
In addition, based upon the height information the low height audio/visual warning is generated.
The radar altimeter is powered by the PP4 bus.

Radar Altimeter Controls and indicators

Radar Altimeter Clearance Height Setting Control

The clearance height can be set by means of the LOW HT rotary control, located on the right glareshield. A clockwise rotation increases its value. The clearance height setting control has two levels of resolution as follows:

– from 0 to 300 ft: 10 ft increments
– from 300 to 5000 ft: 50 ft increments

Similarly, counterclockwise rotation will decrement the clearance height setting value of the appropriate steps. During NAV and A/A (A/A and A/S) POF, when the aircraft is below the selected clearance height setting, the warning facility activates a CAT 1 audio/visual warning consisting of flashing attention getters accompanied by the LOW HEIGHT audio voice message.

In addition a pull up indication is displayed on the HUD and on the MHDD/HDHUD format by means of a flashing arrow which rotates about its center point, such that it always points away from the ground and the LOW HEIGHT caption below it.

As soon as best height becomes greater than 3% of clearance height datum, low height warnings are reset. The low height warning is processed by the NC.

NOTE

Low height warning generation is delayed by 15 seconds when the WOW transition between ON to OFF occurs and NAV or A/A POF is engaged.

Radar Altimeter Clearance Height Setting Display

A four digit display, adjacent to the clearance height setting control, indicates the selected clearance height value.

Radar Altimeter Transmission Control Switch

A two position "RAD ALT / OFF" toggle switch located on the right console systems gangbar controls the radar altimeter transmission. The switch is physically protected in order to prevent an accidental selection of the OFF position (missing low height warning generation in flight. The switch shaft must be pulled up before OFF can be selected. The switch functions are indicated below:

– RAD ALT (fwd). When selected, the Radar Altimeter transmits
– OFF (aft). When selected, the Radar Altimeter does not transmit.

For further details refer to Table , “RADALT OPERATING MODES,” on page 1-369

RADALT OPERATING MODES

RADAR ALTIMETER TRANSMISSION CONTROL SWITCH				
OFF Position		RAD ALT Position		
GROUND	FLIGHT	GROUND (*)	FLIGHT	
OFF Mode	OFF Mode	STANDBY Mode	STANDBY Mode	TRANSMIT Mode
		Power up	> 5000 ft AGL NC logic (**) DAC input (***) XMIT SSK (****)	≤ 5000 ft AGL

NOTE

- (*) During GND POF the radar altimeter transmits but no indications are provided
- (**) Via databus when bank/inclination > 60° and/or the A/C attitude rates exceed ± 60°/sec for more than 2 seconds.
- (***) Via discrete link for stealth purposes.
- (****) Via MDEF, at any time, to inhibit all the emission from the aircraft.

Radar Altimeter Failure Warning

WARNING

THE LOW HEIGHT AUDIO/VISUAL WARNING AND LANDING GEAR AUDIO WARNING ARE LOST.

In all POF a failure of the radar altimeter is provided by the flashing attention getters, attention, RAD ALT voice message and by the RAD ALT DWP caption.

HUD Navigation Format

The radar altimeter height datum is displayed on the HUD Navigation format (in 10 ft increments). If radar altimeter unlocks or when flying above 5000 ft the indication is replaced by the flashing baro figures if radar altimeter only has been selected.

MHDD/HDHUD Format

The radar altimeter height datum is displayed on the MHDD/HDHUD format (in 10 ft increments). If radar altimeter unlocks or when flying above 5000 ft the indication is replaced by the flashing baro figures if radar altimeter only has been selected.

Radar Altimeter Modes of Operation

The radar altimeter has two main operating modes: STANDBY and TRANSMIT.

STANDBY Mode

On ground, at electrical power-up the radar altimeter performs a Start up BIT (SBIT), after which, if successful, standby mode is entered.

In standby mode the radar altimeter emissions are inhibit: this condition can be meet either automatically or manually, according to Table , “RADALT OPERATING MODES,” on page 1-369).

The SBIT is carried out whenever power is applied. Moreover a subset of SBIT is automatically performed whenever a transmit command is received (2 seconds). The transition from standby to transmit mode cannot be performed in case of unsuccessful SBIT.

TRANSMIT mode

The transmit mode is the normal operational mode of the radar altimeter; the RAD ALT transmission control switch must be set to RAD ALT position.

The transmit mode consists of the following sub-modes:

– search
– track
– memory.

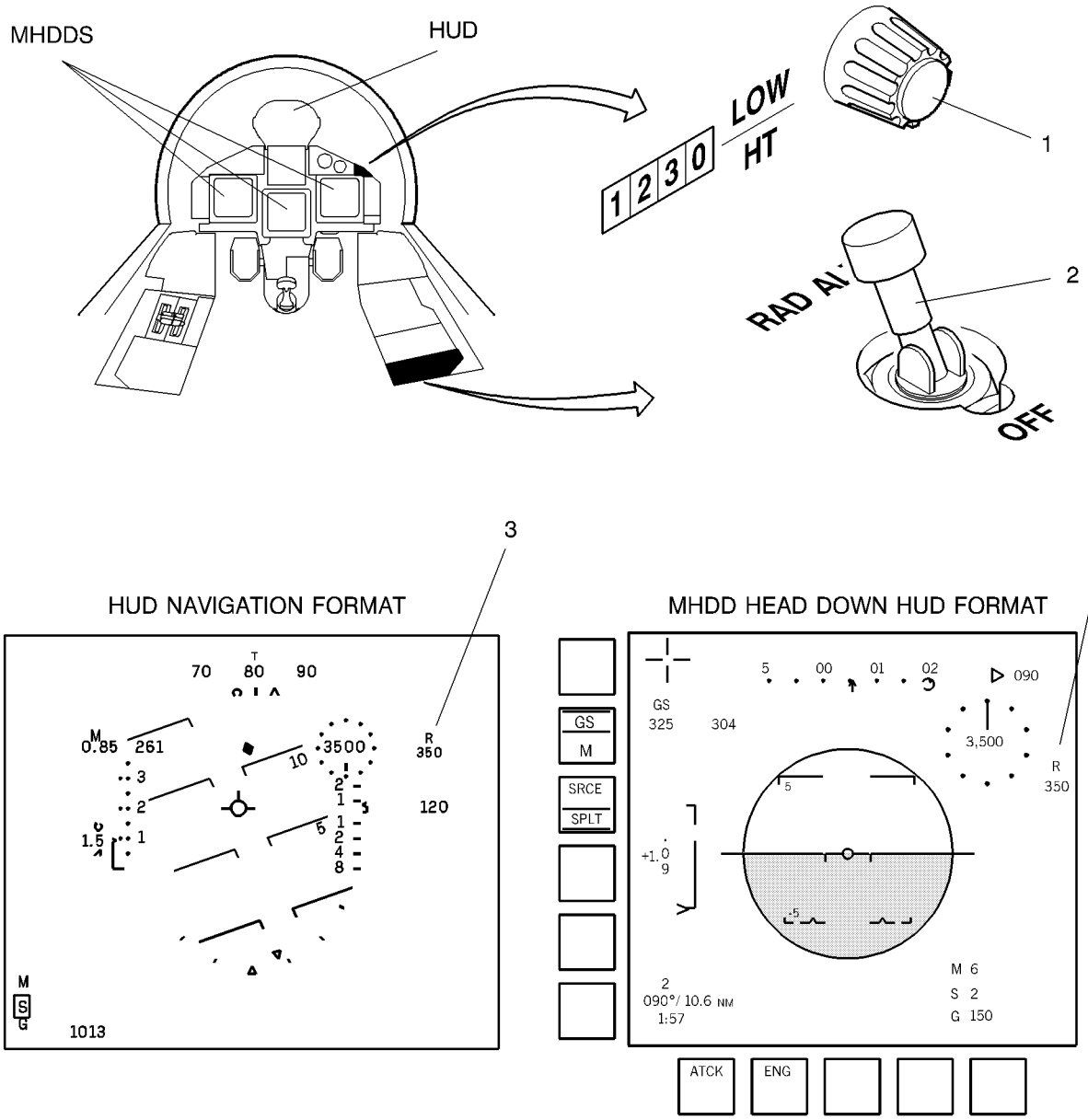
In the search mode the system acquires the initial lock and then automatically switches to the track mode thus providing the height datum.

In the event of a temporary loss of lock, the radar altimeter enters memory mode, providing the last stored value of height for up to one second. If the loss of lock persists, the system switches to the search mode in order to re-acquire the lock.

To ensure correct operation in all flight conditions, transmitter power varies as a function of the perceived height (also for stealth purposes).

CBIT/IBIT Facilities

The system incorporates the CBIT and IBIT facilities.
CBIT starts automatically once SBIT has been successfully completed, and does not prevent the normal operation of the radar altimeter (provided that no failures are detected).
CBIT is performed at fixed rates.
IBIT may be carried out by the ground crew via MDP, it lasts 10 seconds as maximum.



1 RADAR ALTIMETER CLEARANCE HEIGHT SETTING CONTROL AND DISPLAY
2 RADAR ALTIMETER TRANSMISSION CONTROL SWITCH
3 RADAR ALTIMETER HEIGHT INDICATION

Figure 1.174 - Radar Altimeter Controls and Displays

TACAN

(1B-B-34-52-00-00A-043A-A Issue 002)

Introduction

The tactical air navigation (TACAN) system is a radio navigational aid. The equipment consists of two antennas, a transmitter/reciever unit and an antenna switching unit. Control is via the Manual Data Entry Facility (MDEF).

The TACAN equipment provides conventional Air to Surface (AS) and Air to Air (AA) modes. Using the AS Receive mode the system provides magnetic bearing and in AS or AA Transmit/Receive mode the system also provides slant range in nautical miles.

The antenna switching unit automatically selects the antenna recieving the strongest signal.

Function

The TACAN system defaults to ‘on’ following power up. The MIDS toggle switch on the right hand console located within the battery gangbar has two positions. When selected to MIDS the TACAN operates in the Transmit/Receive mode. When selected to OFF the TACAN operates in the Receive mode only.

When AS Receive mode is selected, or when TACAN silent mode is selected via the MDE (XMIT subsystem key), the on-board TACAN transmitter is inhibited. In this situation the TACAN will only provide magnetic bearing against a ground beacon, and no slant range.

A beacon confirms its identity via the Communications and Audio Management Unit (CAMU) to the aircrew’s headset with an audio tone in morse code. The volume of the audio tone is adjusted using a rotary control located on the left rear console.

The range (RNG) and bearing (BRG) information is displayed digitally in boxes on the MHDD/PA format. Selecting the NAV/TAC soft-key to TAC, on the MHDD/HSI format, will still display the range and bearing information but also the TACAN channel number, type and mode in-lieu of the navigation waypoint data, refer to Figure 1.175 . The readout of the TACAN channel, the bearing and the range data can also be displayed on the HUD. The TACAN channel number and type are also displayed on the Dedicated Read-out Panel (DRP) located on the right glareshield, refer to Figure 1.176.

The TACAN system is tested by PBIT, and following a 3 minute warm-up period is fully operational. It is at this stage that the CBIT is initiated. A failure of the system detected by CBIT is shown by the ‘TACAN’ indication on the Dedicated Warning Panel (DWP) and the voice message “TACAN”. If the TACAN function fails (or is not present) the moding keys for TACAN are not lit.

The TACAN has the following three modes of operation:

Air to Surface Receive Mode

In this mode the system only calculates the magnetic bearing to the selected TACAN ground beacon using a signal transmitted from that beacon.

Air to Surface Transmit/Receive Mode

In this mode the system transmits interrogation pulse pairs to determine the slant range in nautical miles to a selected TACAN ground beacon.

Air to Air Transmit/Receive Mode

In this mode the system transmits interrogation pulse pairs to determine the slant range in nautical miles to selected AA TACAN, e.g. tankers and co-operating fighter aircraft.

Operation

This mode of operation and channel selection is via the Navigation AIDS subsystem soft-key, moding keys and the MDEF on the left glareshield. Pressing the TAC ON moding key will set the system to TAC SBY, pressing the moding again will return the system to TAC ON. The selection of TAC AA will cause the deselection of TAC AS and vice versa. Accidentally selecting any boxed moding key will have no effect on the system. The TXRX moding key will not be affected by selecting between the TAC AA and TAC AS moding keys, refer to Figure 1.177 . Pressing the TXRX moding key toggles between Receive mode and Transmit mode. The default selections are shown in Figure 1.177 .

NOTE

If the TACAN is under stealth control the upper TXRX legend of the moding key is not lit as this option is not available.

To Edit TACAN Channel - Input New Channel

To update the current (CRNT) TACAN channel number the pilot can overtype the previous (PREV) TACAN channel number in ROL 3. The pilot can also change the TACAN type in ROL 3 from X to Y by selecting the Y key on the Data Entry Keyboard (DEK), this action will leave the DEK showing X, refer to Figure 1.178 .

On defining the first character, the PREV legend will change to NEW and the second and third characters automatically revert to dashes, ready to recieve the

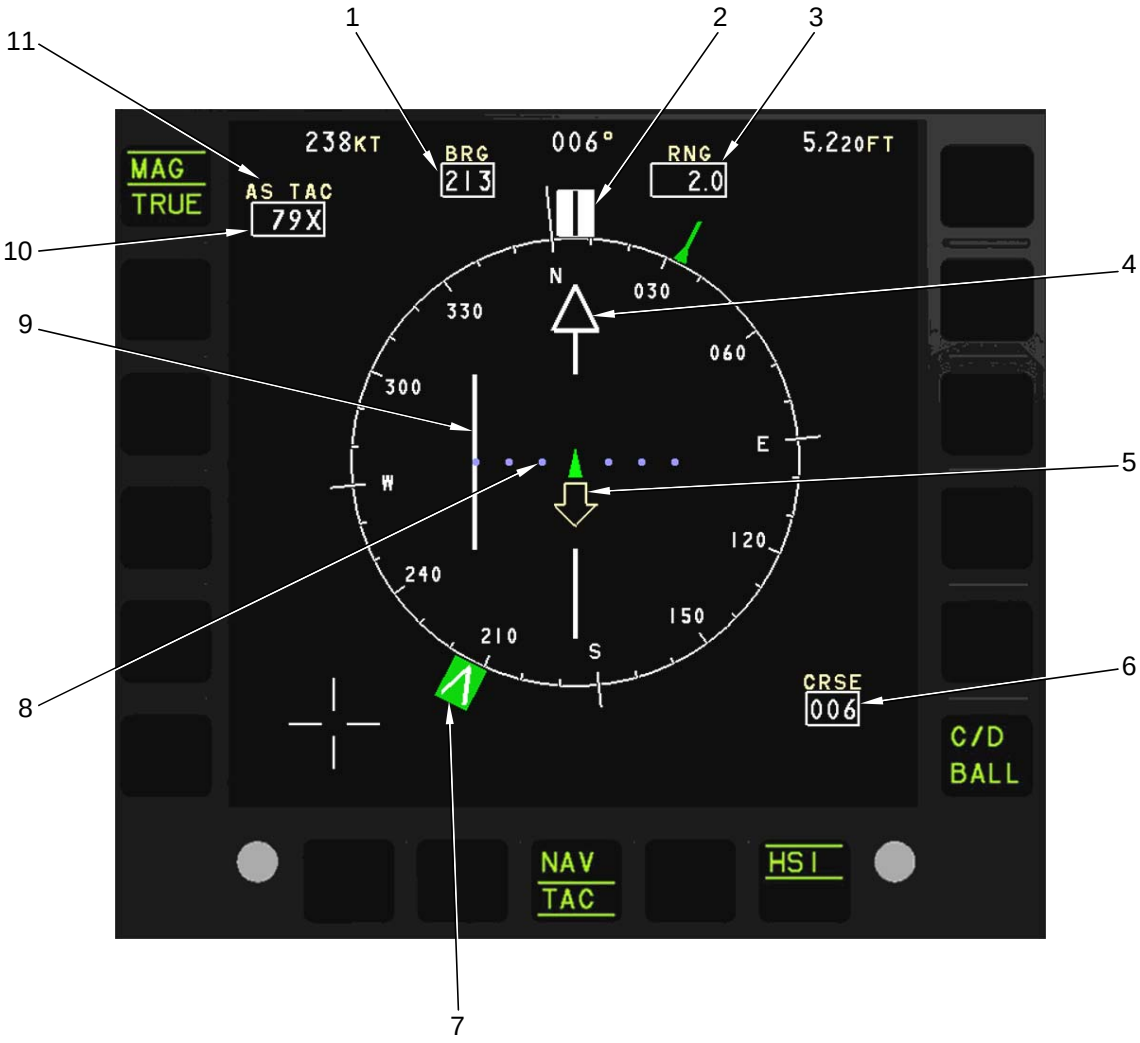
remaining TACAN data. On selection of the ENT key on the DEK the ROL will go blank momentarily, then show the new channel number as CRNT and the previous CRNT channel number as PREV.

To Edit TACAN Channel - Select/Clear Previous

In the NAV POF the TAC DATA moding key is selected as default; TAC DATA can be manually selected in any other POF. The ROL will reconfigure to display the current (CRNT) and previous (PREV) TACAN channel number. If there is no PREV channel number then ROL 3 will show NEW ---X, refer to Figure 1.179.

To select the PREV channel number, select the ENT key on the DEK. The PREV channel number is sent to the system to be used as the CRNT channel number and the information in ROL 2 and ROL 3 is switched.

To clear the PREV channel number select the CLR key on the DEK; in ROL 3 the channel number will be set to dashes and the PREV legend will change to NEW; the channel type will default to X. The CRNT channel number will not change.



1 BEARING TO TACAN BEACON
2 HEADING MARKER
3 SLANT RANGE TO TACAN BEACON
4 COURSE POINTER
5 TO/FROM ARROW
6 COURSE SET INDICATION
7 BEARING POINTER (TO TACAN BEACON)
8 LATERAL DEVIATION SCALE
9 LATERAL DEVIATION BAR
10 TACAN CHANNEL NUMBER AND TYPE
11 TACAN IN AIR-TO-SURFACE MODE

Figure 1.175 - TACAN Display (MHDD/PA Format)

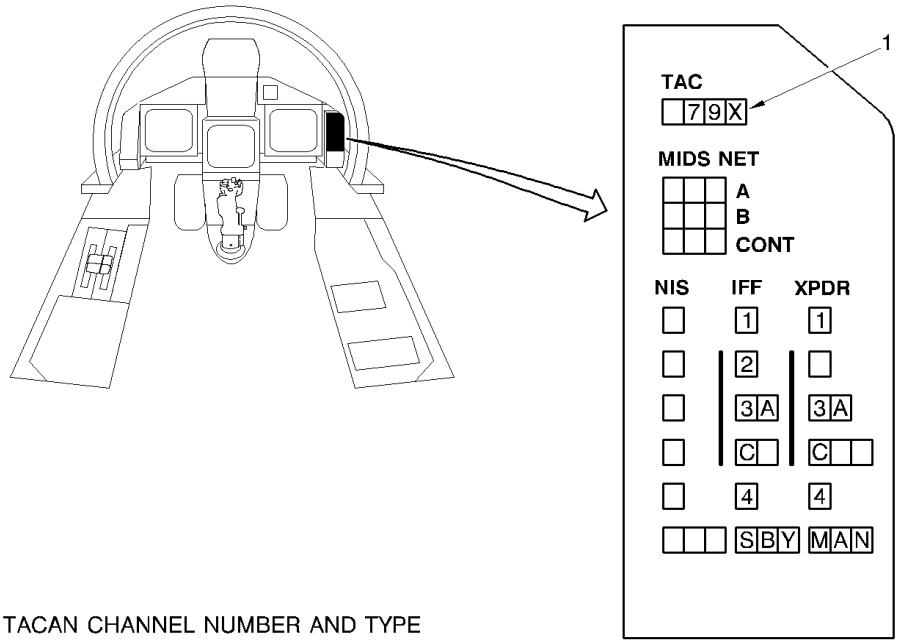
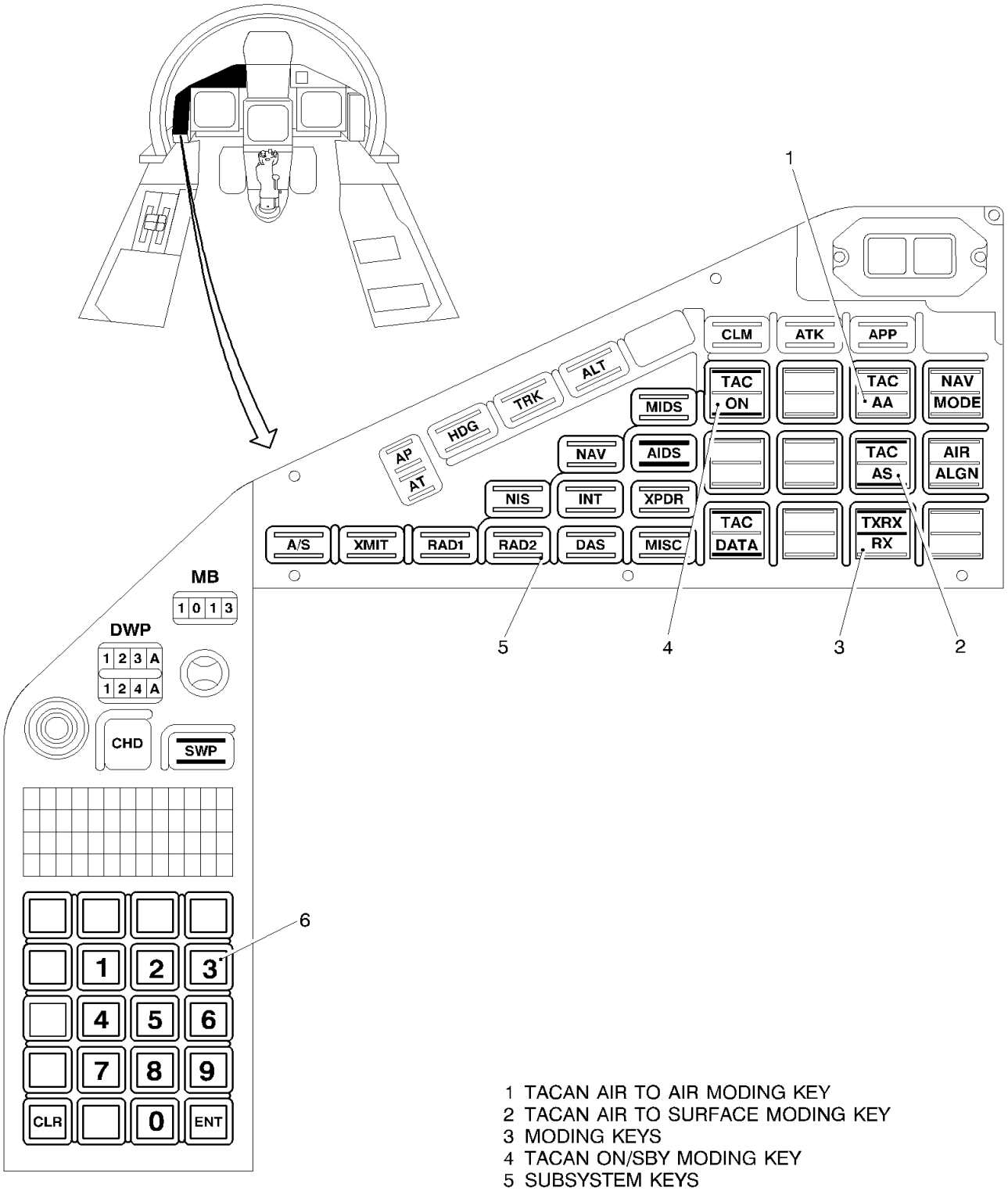
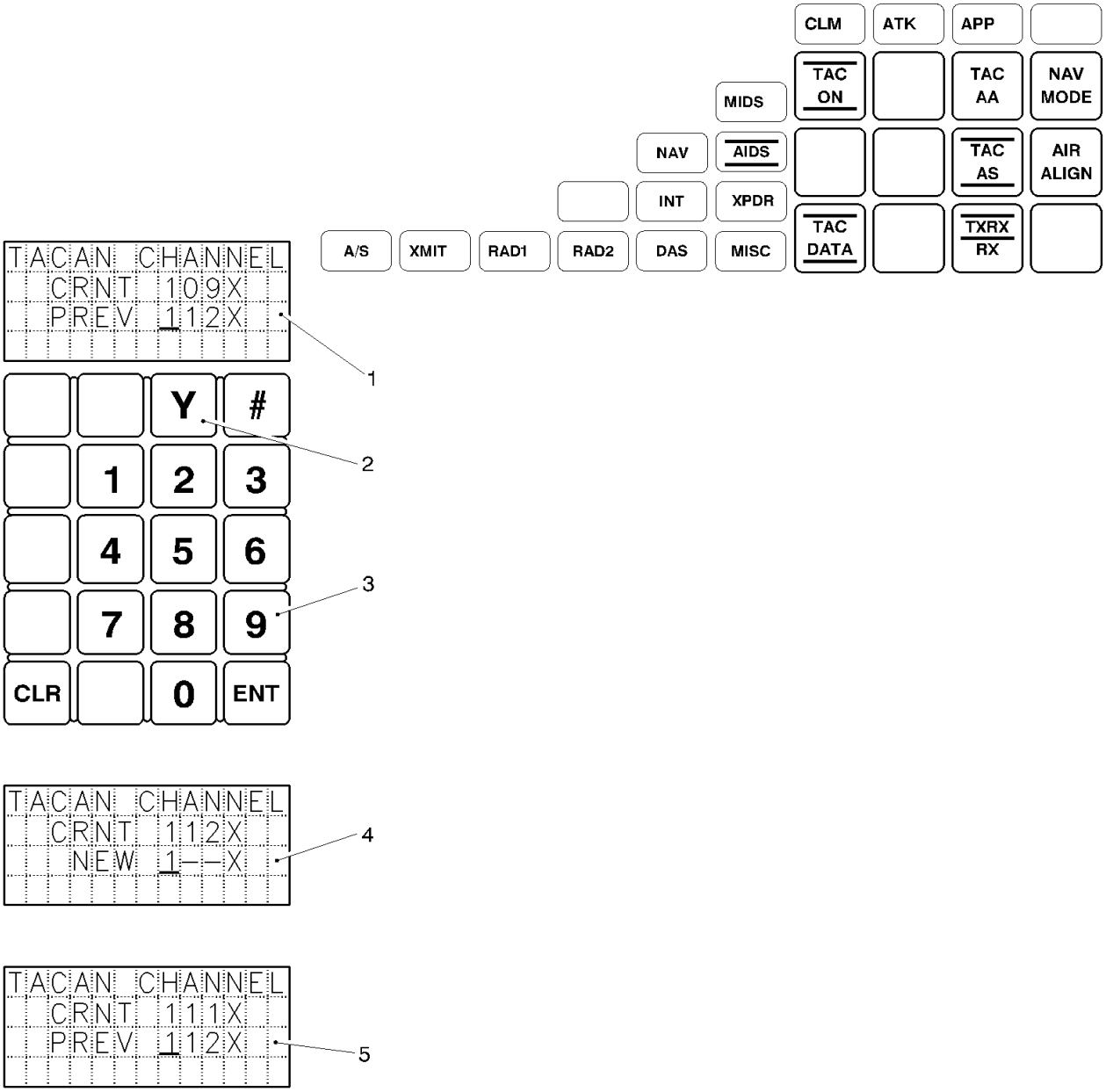


Figure 1.176 - RH Glareshield - Dedicated Read-out Panel - TACAN Channel Number and Type



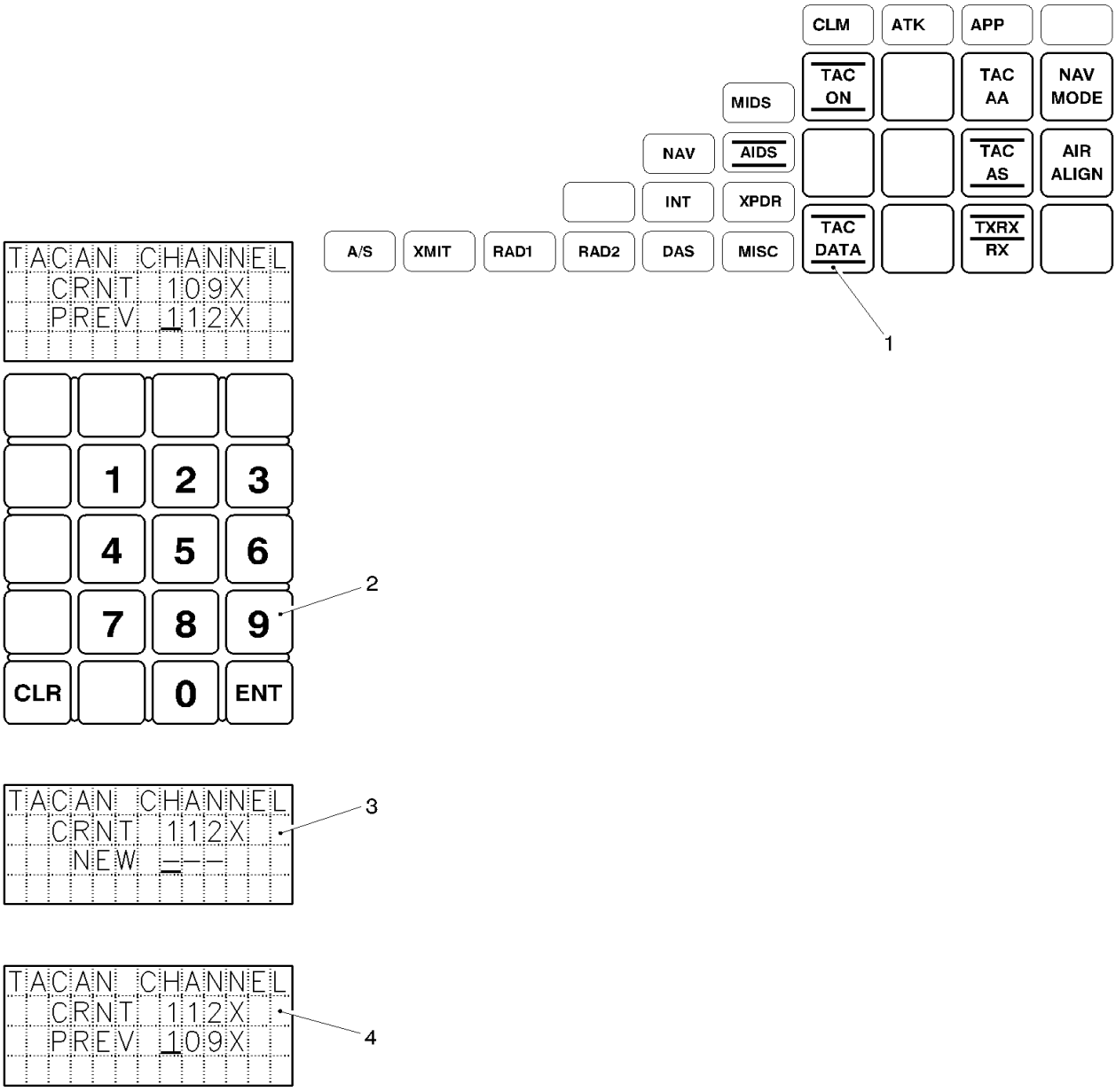
1 TACAN AIR TO AIR MODING KEY
2 TACAN AIR TO SURFACE MODING KEY
3 MODING KEYS
4 TACAN ON/SBY MODING KEY
5 SUBSYSTEM KEYS
6 MANUAL DATA ENTRY FACILITY (MDEF)

Figure 1.177 - TACAN Displays - Left Glareshield (Weight-off-Wheels)



1 ROL 3
2 X/Y DATA ENTRY KEY
3 DATA ENTRY KEYS
4 ROL 3 UPON INPUT OF FIRST CHARACTER
5 ROL 3 UPON PRESSING ENT KEY ON DEK

Figure 1.178 - Edit TACAN Channel - Input New Channel



1 TAC DATA MODING KEY
2 DATA ENTRY KEYS
3 ROL 3 IF NO PREVIOUS TACAN CHANNEL NUMBER
4 ROL 3 UPON PRESSING CLR KEY ON DEK

Figure 1.179 - Edit TACAN Channel - Select/Clear Previous

Navigation System

(1B-B-34-10-00-00A-111B-A Issue 003)

Introduction

Typical Multifunction Head Down Displays (MHDD) associated with the navigation system are shown in Figure 1.180 to Figure 1.195 .

Figure 1.180 - Waypoint Format

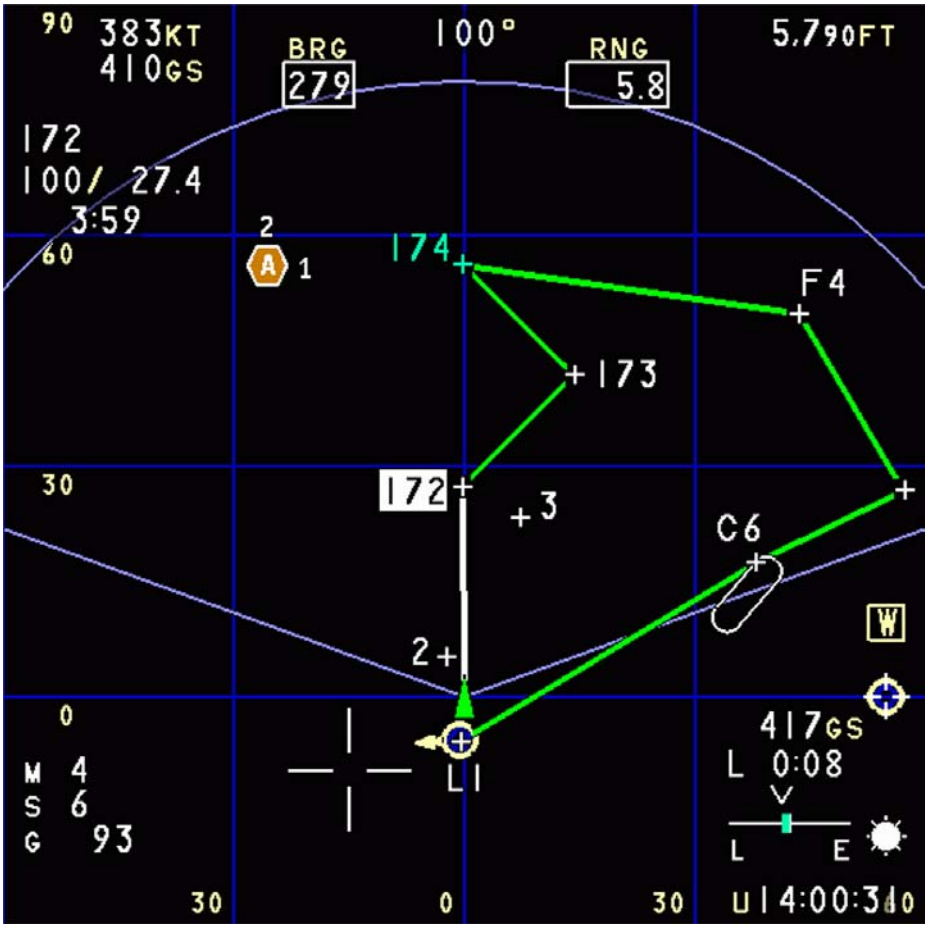


Figure 1.181 - LINS Airborne Alignment Mode

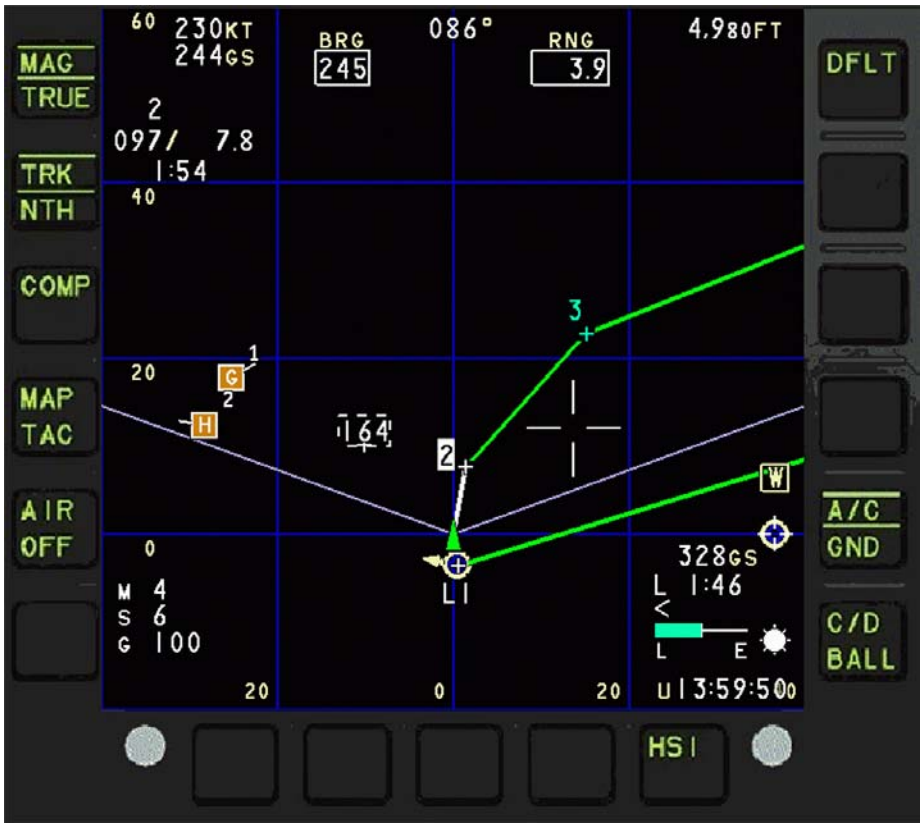
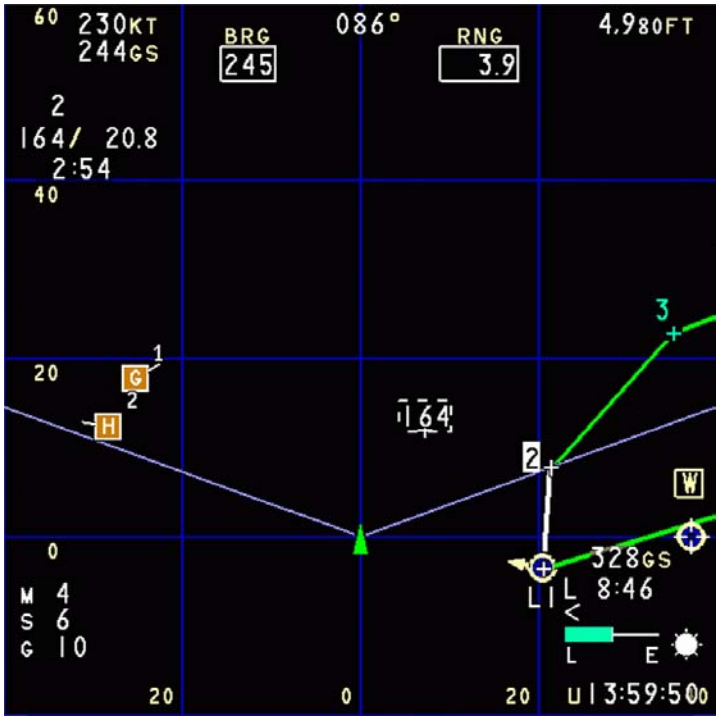


Figure 1.182 - Auto Route Selection

Figure 1.183 - Manual Route Selection

Figure 1.184 - Manual Route Creation



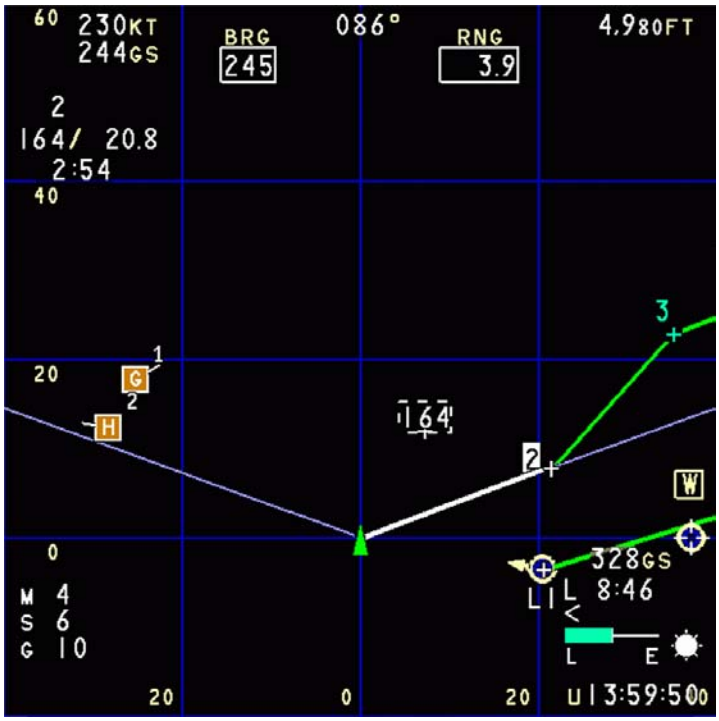


Figure 1.185 - New Track Moding

Figure 1.186 - Identify/Edit Paired Waypoint

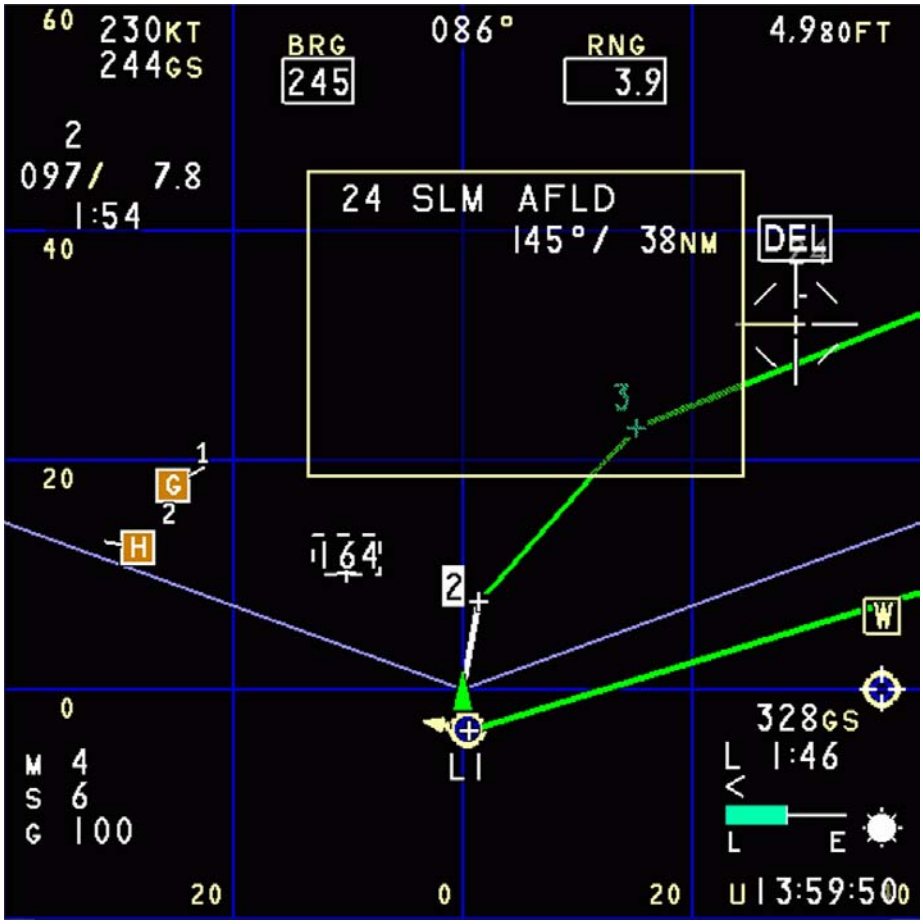
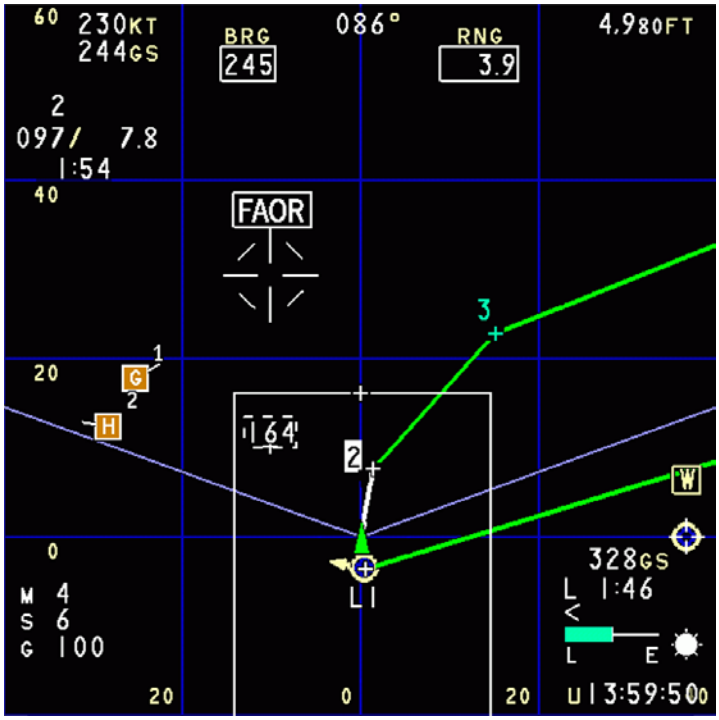


Figure 1.187 - Delete Waypoint Moding

Figure 1.188 - Bullseye Grid Selection



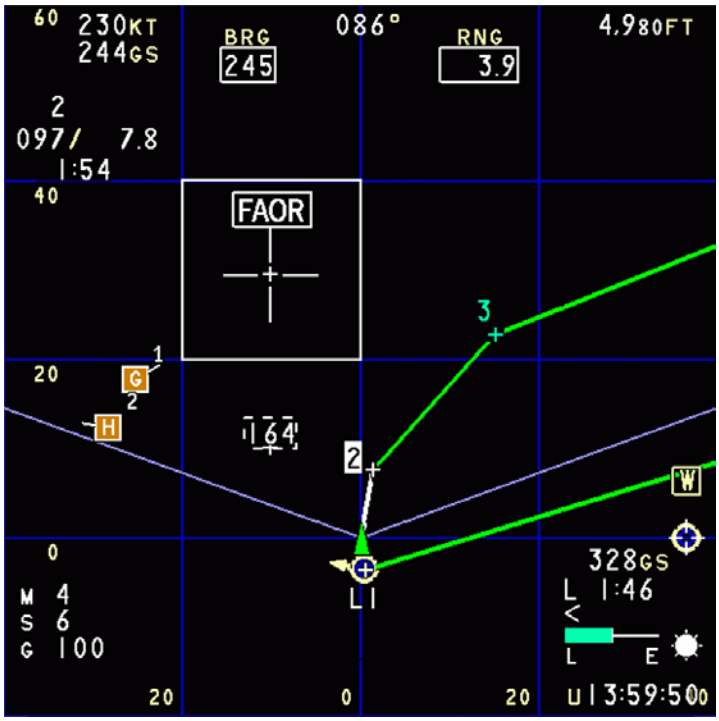
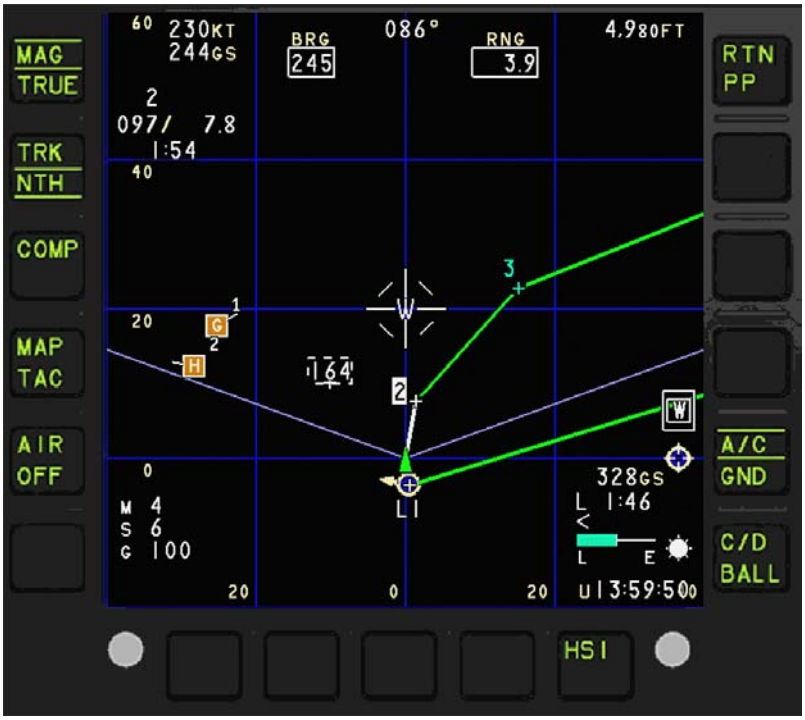


Figure 1.189 - Set FAOR



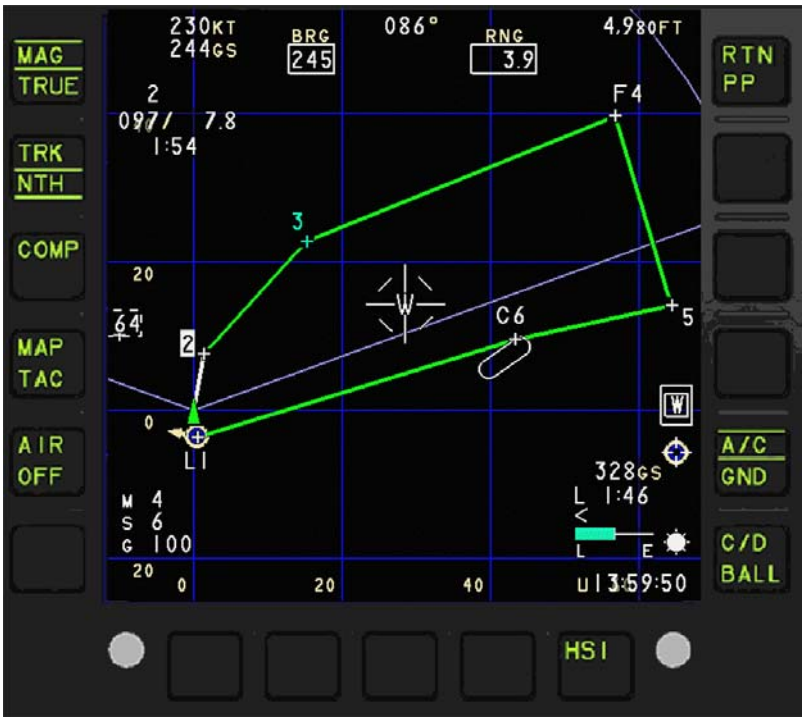


Figure 1.190 - Window-on-the-World Selection

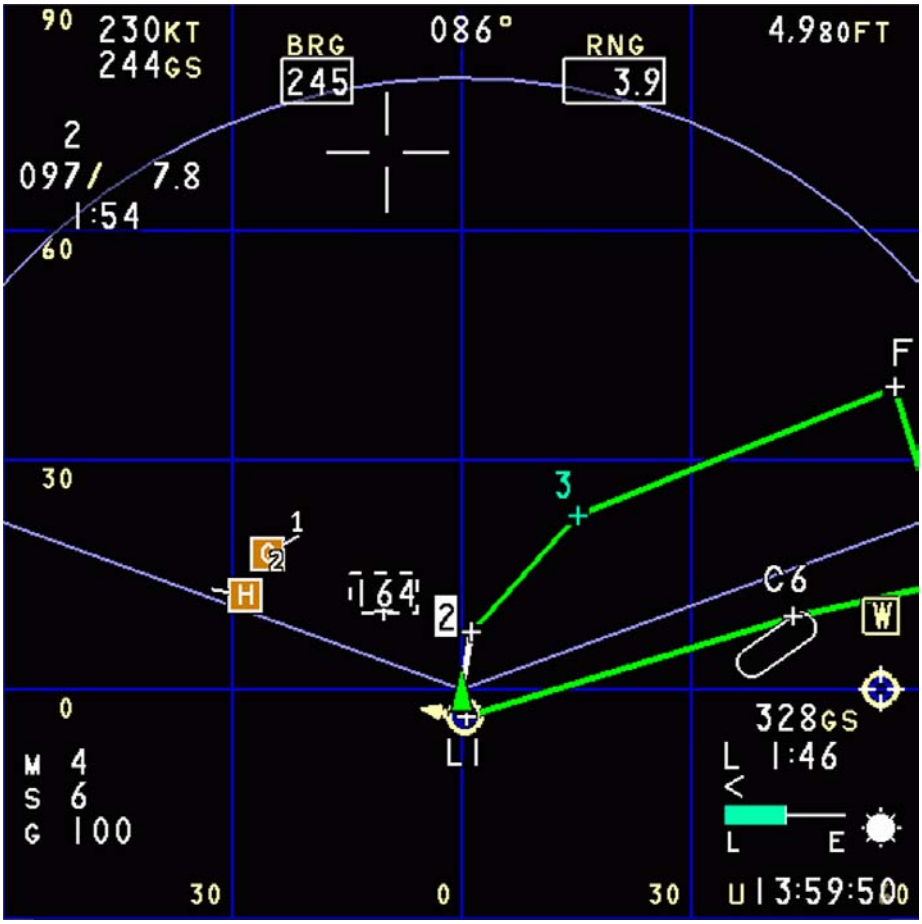
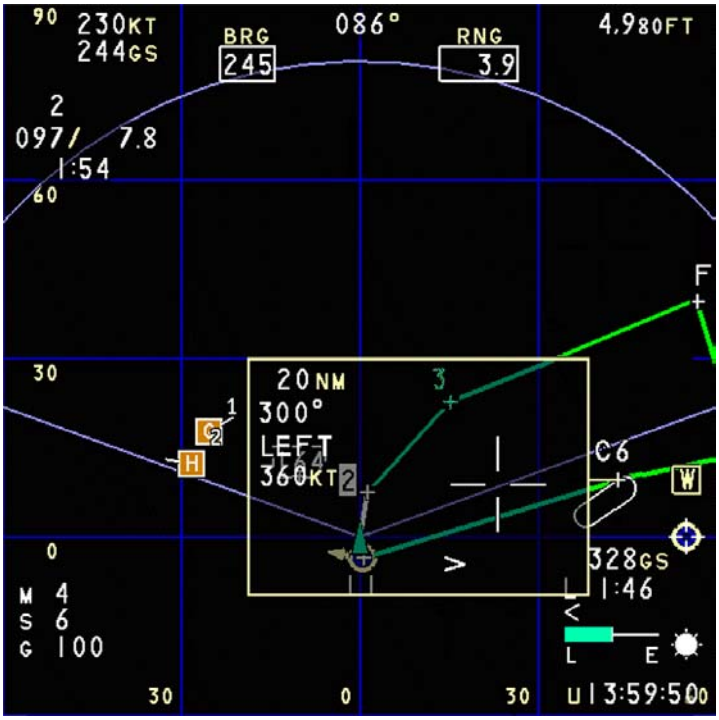


Figure 1.191 - Display Range Scale



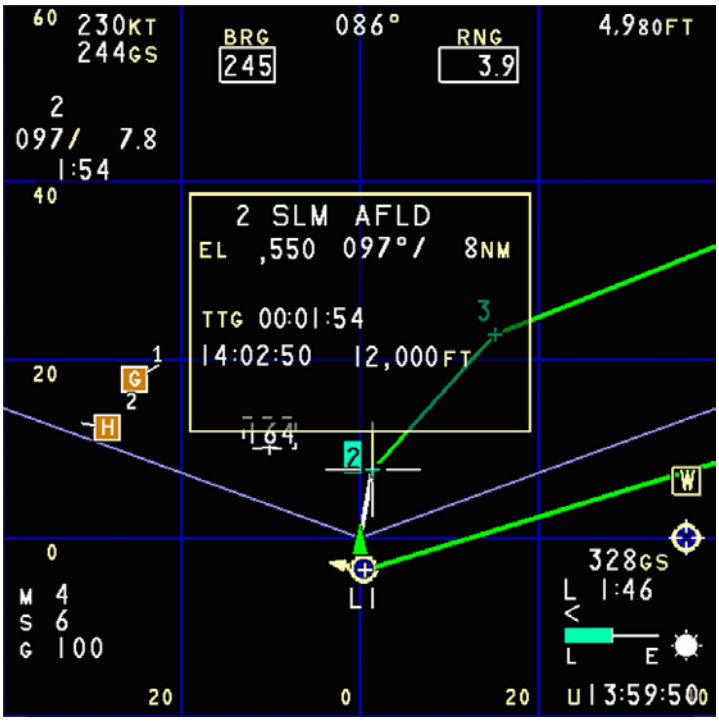
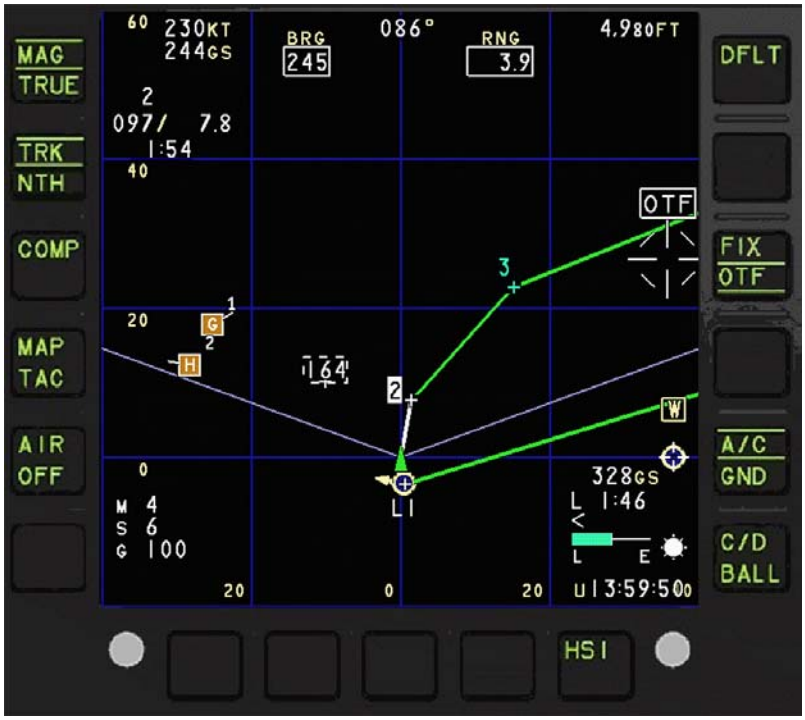


Figure 1.192 - Extra Data on Waypoint (PA Format)



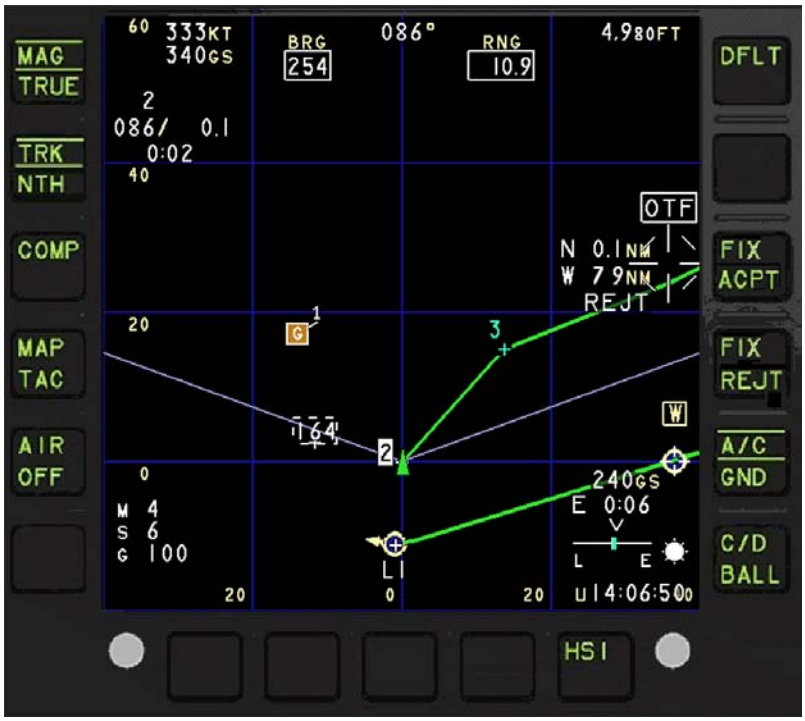


Figure 1.193 - On-Top-Fixing

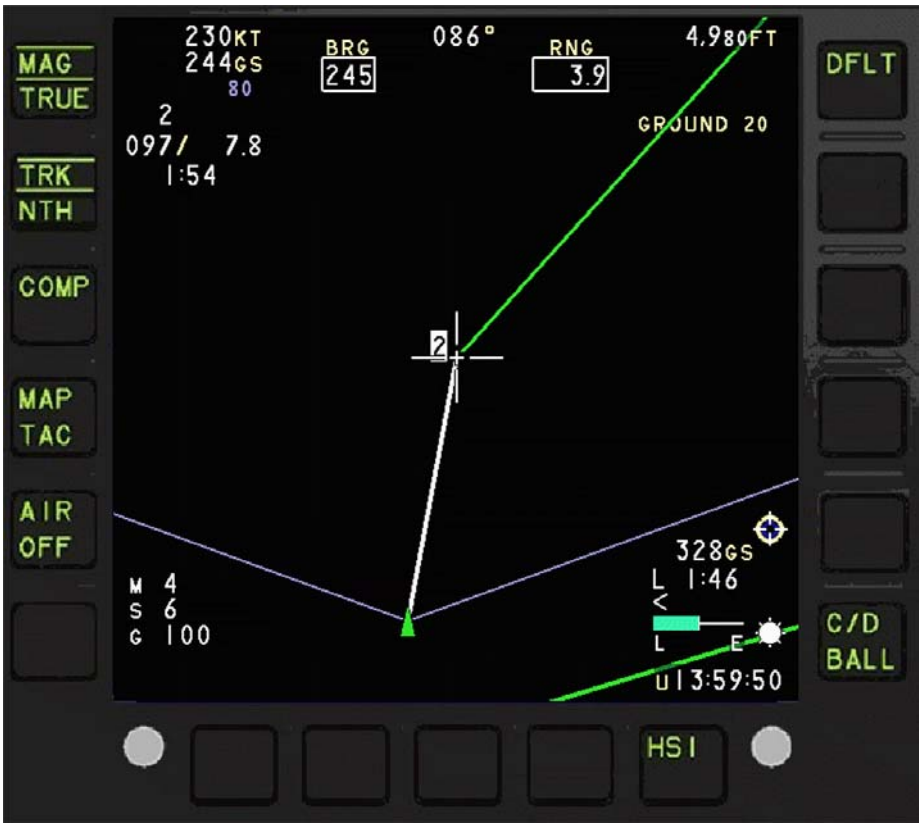


Figure 1.194 - Zoom Window

Figure 1.195 - Autocue Format

COMMUNICATION SYSTEM

Communication Equipment

(1B-B-23-00-00-00A-043A-A Issue 003)

The communication system provides clear and secure air-to-air and air-to-ground communications and audio management. The system consists of two identical and independent V/UHF transceivers, a lower V/UHF Antenna, a fin tip Combined antenna, the communications and audio management unit (CAMU), the multifunctional information distribution system (MIDS) and their associated controls and indicators.

The V/UHF Transceivers provide transmission and reception of radio signals in all different combinations of clear/secure and fixed-frequency/ ECCM modes. Supported modes are HaveQuick I/II and SATURN.

The communications and audio management unit performs the control and management of the aircraft communications and audio warning generation.

The fin tip combined antenna is installed at the top of the fin and it is connected to transceiver 1. This antenna transmits/receives UHF or VHF frequencies and D-band frequencies.

The lower V/UHF antenna is installed at the lower center fuselage, just below the left air intake and it is connected to transceiver 2. This antenna transmits/ receives only VHF or UHF frequencies.

V/UHF Radio

(1B-B-23-21-00-00A-043A-A Issue 003)

Two identical and independent V/UHF transceivers provide transmission and reception of radio signals in all different combinations of clear/secure and fixed-frequency/ECCM modes, operating in the following frequency bands and modulation:

In no ECCM mode:

VHF	108.000 to 155.975 MHz (108.000 to 117.975 MHz receiver only)	AM
UHF	225.000 to 399.975 MHz	AM

In ECCM mode:

UHF	HQ I/HQ II	SATURN
225.000 to 399.975 MHz	AM	MSK

Each transceiver has 24 preset channels and 1 manual channel and incorporates an independent guard receiver. The guard receiver is tuned to the frequencies 121.5 MHz or 243.0 MHz, depending on pilot selection, and independent of the frequency band in which the transceiver is operating.

Each transceiver is connected to a different antenna, the transceiver 1 is connected to the fin tip combined antenna and the transceiver 2 is connected to the lower V/UHF antenna.

Both transceivers are connected to the avionic data bus as remote terminals. A "crypto erase" signal is connected to each transceiver when the seat ejector control is operated.

Electrical power is supplied to the transceiver 1 from the essential DC bus bar PP7 and to the transceiver 2 from the nonessential DC bus bar PP2. The transmitter power output level is 20 W on normal power for fixed frequency and HQ modes, and 30 W for SATURN mode. The transceivers have BIT routines for equipment monitoring.

Communications and Audio Management Unit

(1B-B-23-51-00-00A-043A-A Issue 004)

The communications and audio management unit (CAMU) performs the control and management of the aircraft communication system. The CAMU has the following functions:

- Audio routing, mixing, matching, amplification and conditioning
- Audio interfacing from the two V/UHF transceivers, distribution unit (DU) and TACAN/ MIDS (whichever is fitted)
- Audio interfacing to the two V/UHF transceivers, video voice recorder (VVR) and interface processor unit (IPU)
- Audio interfacing to/from the telebrief ground link
- Intercommunication between the two pilots, and pilots and ground crew
- Generation and control of voice message warnings, attensons and tones
- Communication system management and remoding

The CAMU consists of functional modules interfacing with each other. The functional modules are: a programmable processor module, two audio communication modules, two warning generator modules, an audio filtering and switching module, and an external data bus terminal module.

The programmable processor module enables the remaining functional modules.

The audio communication modules together with the audio filtering and switching module, routes, mixes, matches, amplifies and conditions the communications. Each audio communication module incorporates:

– two redundant and selectable amplifier boards, each with a normal and a reversionary amplifier
– the preset default volume levels for each audio signal
– the default PTT (radio 1 only).

The warning generator modules generate the attensons, the voice warning messages and tones. The generation of Get-U-Home (GUH) discrete warnings is duplicated on the two warning generator modules.
The CAMU audio output to pilot goes via aircrew service package LRIs to the headset.
The pilot actions on CAMU functions are:

– PTT operation
– voice warning message suspension (VOICE OFF)
– audio amplifier selection
– audio volume selection for radio 1, 2, TACAN, MLS, MIDS voice channel A/B, missile tone, telebrief and intercom.
– default volume selection.

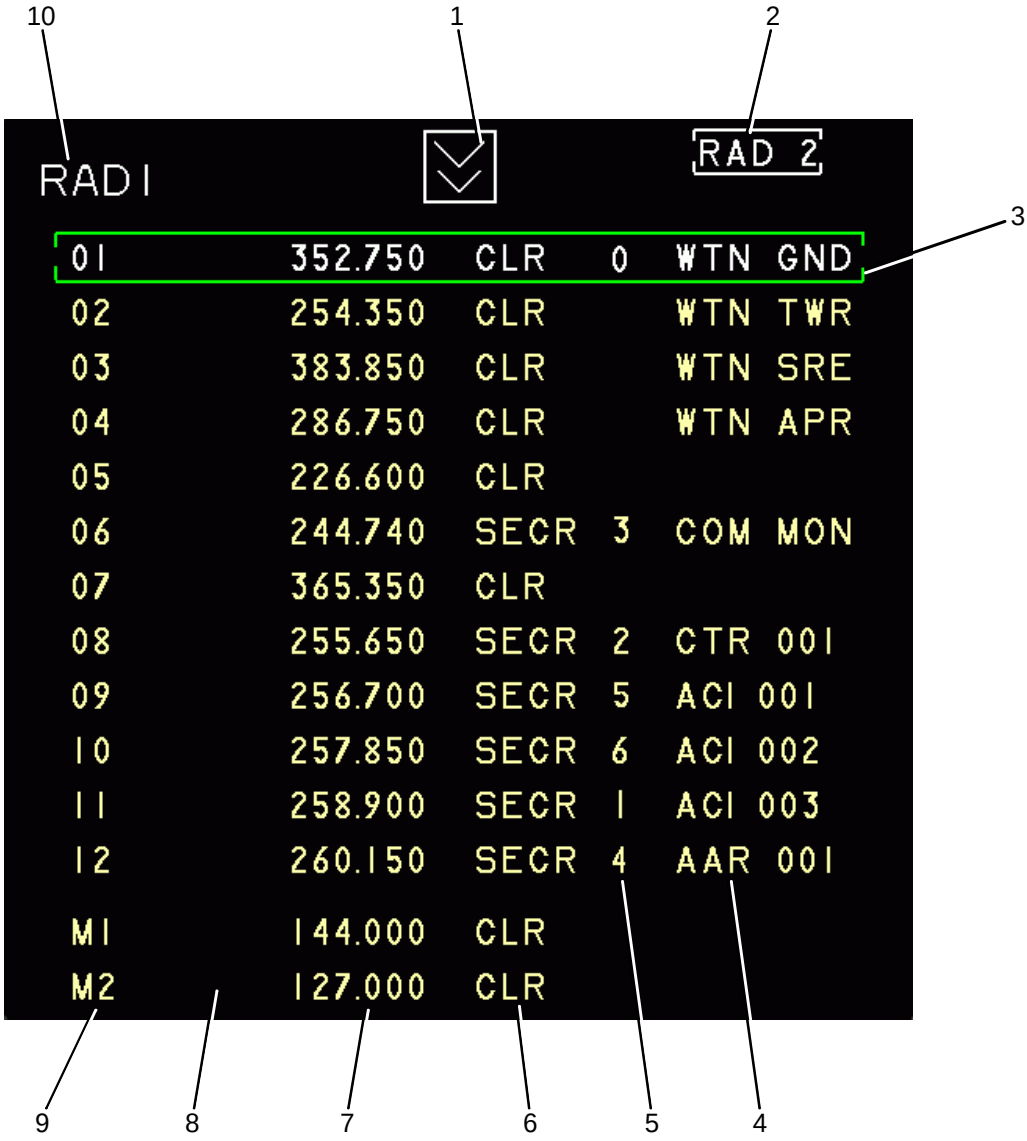
Communication

(1B-B-23-00-00-00A-111B-A Issue 002)

Introduction

The communications equipment (RAD1 and RAD2) data can be displayed on the Multifunction Head Down Display (MHDD) radio format page, refer to Figure 1.196.
The MHDD can display the status of either RAD1 or RAD2, but only half of the list of channels can be displayed at any one time, requiring the pilot to select the required page using the PAGE UP or PAGE DOWN soft-key or by placing the X-Y insert over the page up/page down symbol.
RAD1 and RAD2 can be selected by using the appropriate soft-key on the MHDD or by positioning the X-Y insert over the RAD select icon. For additional information, refer to:

– Communication Equipment pag. 1-396
– Communication Equipment pag. 1-399.



1 PAGE UP/DOWN ICON
2 RADIO SELECT ICON (EITHER RAD1 OR RAD2)
3 CURRENT CHANNEL IN USE (WITH ADDITIONAL INFORMATION)
4 CHANNEL IDENTIFIER
5 KEY OF DAY
6 CLEAR/SECURE STATUS
7 CHANNEL FREQUENCY
8 FREQUENCY HOPSET COLUMN (NATO OR NON-NATO)
9 CHANNEL NUMBER (M = MANUAL)
10 SELECTED RADIO (EITHER RAD1 OR RAD2)

Figure 1.196 - MHDD Radio Format

Communication Equipment

(1B-B-23-00-00-00A-111A-A Issue 004)

General

The communication equipment is operated by controls on the head up panel (HUP), the left hand glareshield, the rear left hand console, the rear right hand console (Battery Gangbar) and the throttles (see Figure 1.197).

The rear cockpit duplicate the communication controls and indications (see Figure 1.198) except the default volume selector switch, the radio1 and radio 2 transmit switches, the voice warning control switch and the MIDS control switch.

Head Up Panel Controls

The HUP contains the radio 1 and radio 2 volume controls, the radio 1 and radio 2 channel selector knobs, and the radio 1 and radio 2 readout displays.

Radio 1 and Radio 2 Volume Controls

The radio 1 and radio 2 volume controls are circular rotary controls. Clockwise rotation increases the audio volume of the respective radio in the pilot headset. Counterclockwise rotation decreases the audio volume.

Radio 1 and Radio 2 Channel Selector Knobs

Each radio channel selector knob is concentrically installed with its respective radio volume control in a single control arrangement, but operates independently. The radio channel selector knob is smaller in diameter and protrudes out of the radio volume control. The radio channel selector knob has two positions: in and out.

In the "in" position, rotation of the knob selects a number of discrete positions. Clockwise rotation of the knob increases the selected radio channel number in steps of 1, from 1 to 25 (1 to 24, are preset channels, and 25 a manual channel). If channel 25 is set, further clockwise rotation selects 1, 2, 3 and so on. Counterclockwise rotation of the knob, decreases the selected channel in steps of 1.

When pulled to the "out" position, the knob selects the emergency frequency 243.0 MHz for transmission and reception.

Radio 1 and Radio 2 Readout Displays

Adjacent to its respective radio volume control and channel selector knob, the radio readout display shows the following parameters:

A. Operating mode:

"CLR" for CLEAR mode
"SECR" for SECURE mode.

B. The readout shows:

"GU" for UHF guard receiver selected
"GV" for VHF guard receiver selected
"-U" for reception or transmission via the transceiver with the UHF guard receiver selected
"-V" for reception or transmission via the transceiver with the VHF guard receiver selected
" " for no guard receiver selected, or emergency channel selected and no reception or transmission
"- " for reception via the transceiver without any guard receiver selected.

The symbols "- ", "-U" and "-V" remain displayed for 3 seconds after the end of the reception or transmission signal.

C. Selected channel number:

"1 to 24" for preset channel
"M" for manual channel 25
"G" for guard emergency select.

D. Frequency or ECCM net associated to the current channel selected (preset, manual or emergency):

###.### for a fixed frequency
HQ1 ### for a HaveQuick I net
HQ2 ### for a HaveQuick II net
SAT###A for a SATURN A net
SAT###B for a SATURN B net.

NOTE

digits identify the frequency or net.

Left Hand Glareshield Controls

The Manual Data Entry Facility (MDEF), on the left hand glareshield, contains the radio 1 and radio 2 subsystem keys and the associated moding keys. Data relevant to the radio 1 and radio 2 subsystems is able to be displayed on the read out lines and entered/edited via the data entry keyboard.

Radio 1 and Radio 2 Subsystem Keys

The radio 1 and radio 2 subsystem are identical in operation and are selected/deselected using the RAD1 or RAD2 subsystem keys (SSK).

Associated Moding Keys

Upon selection of the applicable SSK (RAD 1 or RAD 2 shows boxed) the following modes/data entry options are available on the moding keys (MK):

NRW/BRD — Controls reception over a broad or narrow band

	around the selected frequency (only in clear mode).
MAN/PSET	Allows the operating frequencies to be defined by the pilot for both manual and preset channels. Additionally, Havequick and Saturn modes and their associated net identifiers can be selected in place of a standard frequency via the data entry keyboard operation. It also allows the radio transmission to be preselected between clear and secure.
SQ ON/OFF	Deselects the automatic squelch facility, to assist in hearing weak signals at the expense of increased background noise (only in clear mode).
GRDU/GRDV	Selects the guard receiver to either the UHF or VHF guard frequency, or selects the receiver OFF.
NORM/LOW	Selects between NORMal and LOW transmitter power output, to reduce emission power and enhance stealth characteristics.
HAIL ON/OFF	Allows the pilot to select the Saturn Hail facility, through which a caller can attract the pilot attention that communication is required on a predefined frequency.
TX TIME	Allows the pilot to transmit his time (time of day, TOD) to a receiving platform. Different times may be used for radio 1 and radio 2. When this function is selected, the RX TIME function is occulted and not available for 5 seconds.
RX TIME	Allows the pilot to receive an operating time from another platform. When this function is selected, the TX TIME function is occulted and not available for 5 seconds.

The boxed moding keys correspond to the current channel selected on the radio channel selector. To alter this, press the corresponding moding key (the applicable caption will show boxed).

Rear Left Hand Console Controls

The rear left hand console contains the duplicate PTT switch, the TACAN/MLS volume controls, the intercom volume control, the amplifier selector switch, the default volume selector switch, the missile audio/telebrief volume control and the MIDS A / B volume control.

Duplicate PTT switch

The duplicate PTT switch has 3 positions, 2 momentary positions and a center-biassed position. The switch is labeled RAD 1 - BOTH - RAD 2. The 3 positions are:

BOTH	No transmission on radio 1 or radio 2. Pushed, transmission via radio 1 and radio 2 is enabled simultaneously for a long as the switch is held in this position.
RAD1	When held, transmit on radio 1
RAD2	When held, transmit on radio 2

NOTE

When the Default Volume Selector switch is at the DFLT VOL position, transmission is restricted to radio 1 only.

TACAN/MLS Volume Controls

These controls are coaxial, the center (top) control is for TACAN and the outer (bottom) control is for MLS. Clockwise rotation increases the audio level and counterclockwise rotation decreases this level.

Intercom Volume Control

The intercom volume control is a rotary control labeled I/C. Clockwise rotation of this control increases the intercommunications volume level, counterclockwise rotation decreases this level.

Amplifier Selector Switch

The amplifier selector switch is a two-position toggle switch labeled NORM and REV in the front and rear cockpit.

Front Cockpit Amplifier Selector Switch

NORM The selection of the audio amplifier is automatic by the CAMU, depending on the status of the audio amplifier:

– For a good status, the CAMU automatically selects the normal amplifier of audio module 1. The front cockpit selected audio signals are connected to the front cockpit headset. The audio signal levels are controlled with the front cockpit audio controls.
– For a fail status, the CAMU automatically selects the reversionary amplifier of audio module 2. The levels of the front cockpit audio signals are controlled with the rear cockpit audio controls.

REV — This position overrides the automatic amplifier selection of the CAMU.

Rear Cockpit Amplifier Selector Switch

NORM The selection of the audio amplifier is automatic by the CAMU, depending on the status of the audio amplifier:

– For a good status, the CAMU automatically selects the normal amplifier of audio module 2. The rear cockpit selected audio signals are connected to the rear cockpit headset. The audio signal levels are controlled with the rear cockpit audio controls.
– For a fail status, the CAMU automatically selects the revisionary amplifier of audio module 1. The levels of the rear cockpit audio signals are controlled with the front cockpit audio controls.

REV — This position overrides the automatic amplifier selection of the CAMU.

Default Volume Selector Switch

The default volume selector switch, only in the front cockpit, is a two-position switch labeled NORM VOL and DFLT VOL.

NORM VOL — The volume of each audio signal, front and rear cockpit, is controlled with inputs to the CAMU.

DFLT VOL — The volume of each audio signal, front and rear cockpit, is the default level preset in the CAMU. Also, the default PTT is selected to restrict transmissions to radio 1 only in front cockpit and radio 2 only in rear cockpit. The individual volume control inputs to the CAMU have no effect.

To prevent inadvertent selection, the switch must be pulled before placing it to the DFLT VOL position.

Missile Audio/Telebrief Volume Control

The missile audio/telebrief volume control is a rotary control labeled MSSL and TB.

On ground, clockwise rotation increases the level of telebrief volume and counterclockwise rotation decreases this level. Pushing the control, transmission via the telebrief link is enabled for as long as the control is held in this position. The control is biased to the upper position.

In flight, clockwise rotation increases the level of missile audio volume and counterclockwise rotation decreases this level.

Rear Right Hand Console Controls

The radio 1 and radio 2 transmit switches and the voice warning control switch are contained on the rear right hand console, inside the battery Gangbar.

Radio 1 and Radio 2 Transmit Switches

The radio 1 and radio 2 transmit switches are two-position, toggles switches, labeled RAD1 (or RAD2) and OFF. When placed to RAD1 (or RAD2) position, transmission via its corresponding transceiver is available. When placed to OFF, transmission via its corresponding transceiver is disabled, reception is operative.

Voice Warning Control Switch

The voice warning control switch is a two-position toggle switch, labeled VOICE and OFF. When placed to VOICE, the voice warning messages are made audible from the CAMU. When placed to OFF, the warning messages (except the catastrophic warnings) are not audible to the pilot. To prevent inadvertent operation of the switch, the pilot must pull the switch before placing it to the OFF position.

Communication Control Switch

The communication control switch is placed on the throttle top unit and is a six-position toggle switch, spring biased to center position:

Forward Transmission via radio 1 is enabled for as long as the switch is held in this position

Rearward Transmission via radio 2 is enabled for as long as the switch is held in this position

Up

Voice Warning Suspend (VWS) is selected and the communications mute (all communications except the intercom between pilots are muted) is enabled. The communications mute is enabled only for the duration that the switch is held in the up position.

The Voice Warning is suspended as follows:

– If the switch is moved upwards for less than 15 seconds, the VWS is enabled for 15 seconds. If there is a current voice warning when the VWS is selected, the voice warning stops. If a new voice warning of a higher category occurs within the 15 seconds period, the new voice warning will be played immediately. At the end of the suspended period, the voice warnings suspended will be played in accordance with their prioritization. If there is no current voice warning when the VWS is selected, then a subsequent incoming voice warning will be played immediately.
– If the switch is moved upwards for more than 15 seconds, the VWS is enabled for the duration that the switch is held in the up position. If there is a current voice warning when the VWS is selected, the voice warning stops. If a new voice warning of a higher category occurs during the VWS selection, the new voice warning will be played immediately. At the end of the suspended period, the voice warnings suspended will be played in accordance with their prioritization. If there is no current voice warning when the VWS is selected, then a subsequent incoming voice warning will be played immediately.
– Selection of the VWS does not inhibit the presentation of catastrophic warning messages.

Down Direct voice input (DVI) press to recognize (not for PSP1)

Center Transmission via either transceiver is not influenced by this position

Center push Transmission via radio 1 and radio 2 is enabled simultaneously for as long as the switch is held in this position.

NOTE

When the Default Volume Selector switch is at the DFLT VOL position, transmission is restricted to radio 1 only.

Communication Warnings

On the dedicated warning panel (DWP), the following captions are presented:

VOICE	(CAT 3 - amber) Indicates a failure of the generation and control of voice message warnings, attensons and tones in the CAMU. The VOICE caption is accompanied with flashing attention getters.
COMMS	(CAT 3 - amber) Indicates a failure of HW/ SW reported by the CAMU or a failure of any V/UHF transceivers, or upon selection a radio channel, channel not available or illegal. The COMMS caption is accompanied with flashing attention getters and the "comms" voice warning message.

The following voices are used to warn the pilot:

Beep	(CAT 4) Simultaneous CLR/SEC transmission. Any radio transmission in CLEAR mode is attempted while another SECURE transmission through the other radio or MIDS (if operative) is taking place (or vice versa).
Frequency	(CAT 4) Radios common tuning. Simultaneous transmission on both radios using frequencies separated 50 kHz or less.
Hail Radio 1	(CAT 4) A signal threshold on the hailing frequency is detected while the radio 1 is operating in SATURN mode.
Hail Radio 2	(CAT 4) A signal threshold on the hailing frequency is detected

while the radio 2 is operating in SATURN mode.

Communication MDE and X-Y Functions

The Manual Data Entry Facility (MDEF) allows data to be manually entered or manipulated within the aircraft avionics subsystems. Within the MDEF data relevant to the RAD 1 or RAD 2 subsystems is able to be displayed on the Read Out Lines (ROL) and entered/edited via the Data Entry Keyboard (DEK) and the Toggle Switch. The X-Y controller, located on the right throttle may be used to browse the frequency channel lists that are presented on the MHDD/Radio Format.
MDEF functionality with respect to the RAD 1 (2) subsystems is as follows:

– Enter and edit manual and preset channel information
– Select between clear and secure voice communications
– Select fixed frequency modes of operation
– Select ECCM modes of operation
– Receive and transmit time status
– Select Saturn HAIL between on and off.
– Select between UHF and VHF guard receiver modes of operation.
– Select between narrow and broad bandwidths
– Select between normal and low power
– Override the automatic squelch facility.

X-Y functionality with respect to the RAD 1 (2) subsystems is as follows:

– Select between the Radio 1 and Radio 2 frequency channel lists
– Page through the Radio 1 and Radio 2 frequency channel lists.

Manual and Preset Channels

The initial frequencies assigned to the 24 preset channels are loaded via the PDS. The initial frequency of the manual channel is set to the last stored value. The pilot may edit the frequency of any channel. The MAN/PSET MK allows the operating frequencies to be modified by the pilot for both the MAN and PSET channels. For the MAN channel the previous manual frequency is stored in memory and can be easily reselected to be used. Alternatively, a new MAN frequency can be specified.

Editing Manual Channel Information

On selection of the RAD 1 or RAD 2 subsytem the DEK, ROL and MK configure to the default moding (Figure 1.199). The ROL show the current MAN frequency on ROL 2 and the previous MAN frequency on ROL 4. To use the previous MAN frequency the pilot simply presses ENT (Figure 1.200). The previous MAN frequency is sent to the communication system to be used as the current MAN frequency, and the current MAN frequency as was now becomes the previous MAN frequency.
Alternatively the pilot may enter new channel information by altering the displayed previous frequency (Figure 1.201), selecting clear or secure and, if secure, specifying the KOD number (Figure 1.202). Selecting ENT confirms the new MAN frequency as the current MAN frequency.
If a Havequick I or II network is to be entered the pilot must specify type I or II (type I is selected by default), enter the network channel number, select clear or secure and specify the KOD number, if applicable (Figure 1.203). If Havequick II is selected the pilot must also specify NATO or non-NATO hopsets. Selecting ENT confirms the new MAN frequency as the current MAN frequency.
If a Saturn network is to be entered (Figure 1.204) the pilot must specify the net channel number, net channel mode (A or B), clear or secure, KOD number (if applicable) and NATO or non-NATO hopsets. Selecting ENT confirms the new MAN frequency as the current MAN frequency.
Whenever any changes are made to the manual channel the channel information on the MHDD/ Radio format is updated. If the manual channel is currently in use then the changes are also reflected in the radio readout displays on the HUP.

Specify/Edit Preset Channel

On selection of the RAD 1 or RAD 2 subsytem and selecting the PSET mode via the MAN/PSET MK the MDEF, ROL and DEK reconfigure to show the details of the currently selected preset channel number (if a PSET channel is selected on the HUP) and its associated frequency (Figure 1.205). If a MAN channel or emergency frequency is currently selected on the HUP then the ROL configure to allow a PSET channel to be manually specified by the pilot. The pilot is then able to overtype the frequency associated with the preset channel with the required new frequency. Selecting ENT updates the communications system with the new data. In addition, the preset channel information on the MHDD/Radio format is updated. If the details of the preset channel currently in use are modified then the changes are also reflected in the radio readout displays on the HUP.

Clear and Secure Voice Communication

The pilot is able to select between clear and secure voice communications for both fixed frequency and frequency hopping ECCM modes of operation

(Figure 1.202). Clear or secure communication is possible on all 24 preset channels and the manual channel. The availability of secure mode depends upon valid KOD cryptovariables. If valid KOD cryptovariables are not loaded then the option to define a channel as secure is unavailable.

The status of the clear/secure setting for the currently selected channel on each radio is permanently displayed on the HUP. The clear/ secure status of all channels is displayed on the MHDD/Radio format and for individual channels on the MDEF ROL. The default status for a channel is clear. Channels may be allocated secure status either on PDS load or by manual selection via the MDEF.

Selection of a secure channel automatically selects the broad bandwidth and switches the squelch filtering to ON.

ECCM Modes of Operation

To aid communications in the ECM jamming environment Havequick I and II, and Saturn frequency hopping ECCM communications are available. Havequick II and Saturn are capable of using either NATO or non-NATO hopsets. These modes require an accurate UTC system time (Time of Day) and Word of Day (WOD). If TOD and WOD are not available the ECCM modes are not available for selection. Selection of Saturn mode or Havequick I or II secure voice mode automatically selects broad bandwidth and switches the squelch filtering to ON.

Time Synchronization

To ensure satisfactory operation of the ECCM modes the pilot has the means to receive (Figure 1.206) and transmit (Figure 1.207) an accurate update of time over the air. If the value of the system time supplied to the Radios degrades to a level which jeopardizes the correct operation of the ECCM modes, or if the system time becomes unavailable, then a CAT 3 COMMS warning is generated to prompt the pilot to obtain a time update.

Cryptovariables

Cryptovariable codes are necessary for operation of the ECCM modes and for secure speech encryption and decryption. KOD cryptovariables are used for voice encryption and decryption. WOD cryptovariables are used for the ECCM functions. All Radio cryptovariables (six KOD and six WOD) are loaded via a fill gun. A KOD cryptovariable is stored for each channel and the initial allocation of a KOD number to individual channels is defined by the PDS channel information data. The pilot is able to alter the KOD assigned to a channel (Figure 1.202).

Saturn Hail

Selection of Saturn enables the monitoring of a hail frequency, provided that a hailing frequency has been loaded via PDS. A different hailing frequency is able to be loaded for each radio. The frequencies can only be entered by PDS load and cannot be altered by the pilot. The hail facility is enabled by default, but the pilot is able to select hail on or hail off via the MDEF whilst in Saturn mode, or preselect hail off/hail on prior to entering Saturn mode (Figure 1.207). If no hailing frequency has been loaded for either or both radios, then the HAIL ON/OFF MK will be occulted for the respective radio(s).

Guard Receiver Mode Selection

The pilot is able to individually set each Radio to receive on the guard UHF or VHF frequencies (Figure 1.209). The power up default setting is UHF. The guard monitoring function enables the pilot to monitor both guard frequencies simultaneously and is available in both the fixed frequency and ECCM modes. Manual selection between UHF, VHF and OFF is made via the MDEF GRDU/GRDV MK and the selection is shown on the radio readout display on the HUP. The guard receiver is only available in fixed frequency operation mode.

Transmission/Reception on Emergency Frequencies

Selection of the UHF emergency frequency (243 MHz), by pulling the Radio 1 or Radio 2 channel selector knob to the out position, and whether transmitting or receiving on this frequency is indicated on the HUP radio readout display (Figure 1.208).

When the pilot deselects the UHF emergency frequency channel the radio reverts to the channel that was previously selected on the channel selector, provided that the channel selector has not been rotated during emergency channel selection.

To transmit on the VHF emergency frequency (121.5 MHz) the pilot must enter this frequency into the manual channel, unless it has previously been allocated to a preset channel.

Selecting Bandwidth

To aid coherent communication the pilot is able to select between narrow and broad bandwidth depending on the bandwidth of the station with which he wishes to communicate (Figure 1.210). The default setting is narrow. Manual selection of bandwidth is only available in the fixed frequency clear voice and Havequick I and Havequick II clear voice modes. Broadband is automatically selected when in Havequick I or II secure, Saturn or fixed frequency secure modes and when in these modes the NRW/BRD MK is unavailable for selection.

When the radio stops operating in these secure modes the system sets the bandwidth to its previously manually selected state and the MK becomes available for selection.

Selecting Transmitter Power

Manual selection between high (normal) and low transmitter power is provided (Figure 1.211). High power is used for long range communications and low power typically for short range, stealth, when flying in high terrain, dense air traffic, in formation or other operational reasons. High (normal) power is the default.

Selecting Squelch Mode

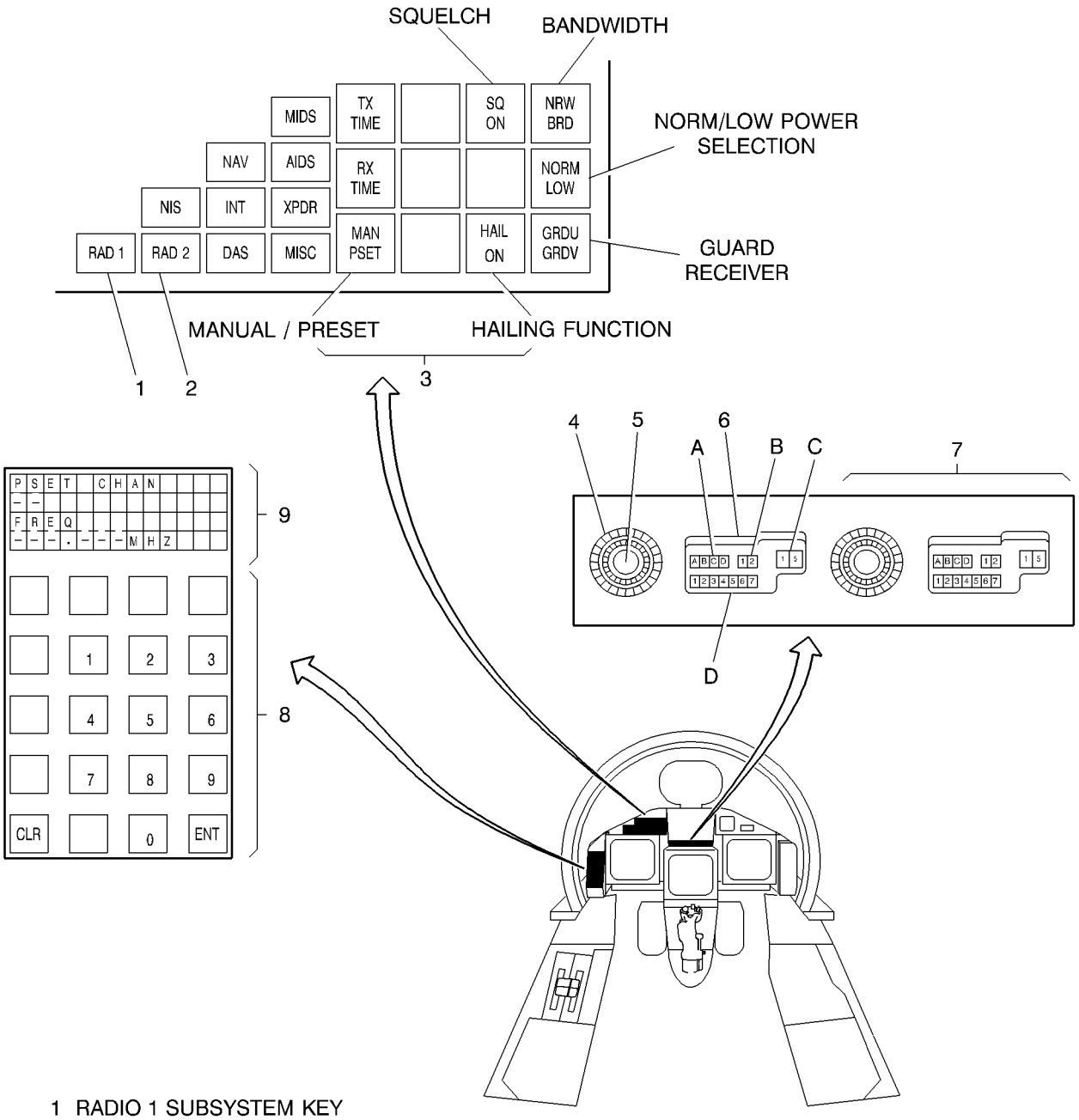
The squelch function rejects unwanted weak signals to improve message clarity (Figure 1.212). On power up the squelch function defaults to ON. The pilot is able to manually switch off the squelch function to amplify weak signals if required. Manual selection of the squelch function is only available in the fixed frequency clear voice and Havequick I and Havequick II clear voice modes. Squelch is automatically selected to ON when in Havequick I or II secure, Saturn or fixed frequency secure modes and when in these modes the SQ ON/OFF MK is unavailable for selection. When the radio stops operating in these secure modes the system sets the squelch function to its previously manually selected state and the MK becomes available for selection.

Browse Radio Lists

The majority of the radio channel information is displayed on the MHDD/Radio format (Figure 1.213). The format is available in all POF and is accessed by selection of the FREQ SK on the MHDD Group C head (right MHDD, by default). The format includes details of channel number, frequency or network identifier, station identifier, clear/secure status, current Key of Day (KOD) number for that channel (if secure) and whether Nato or non-Nato hopsets are selected in Havequick II or Saturn modes.

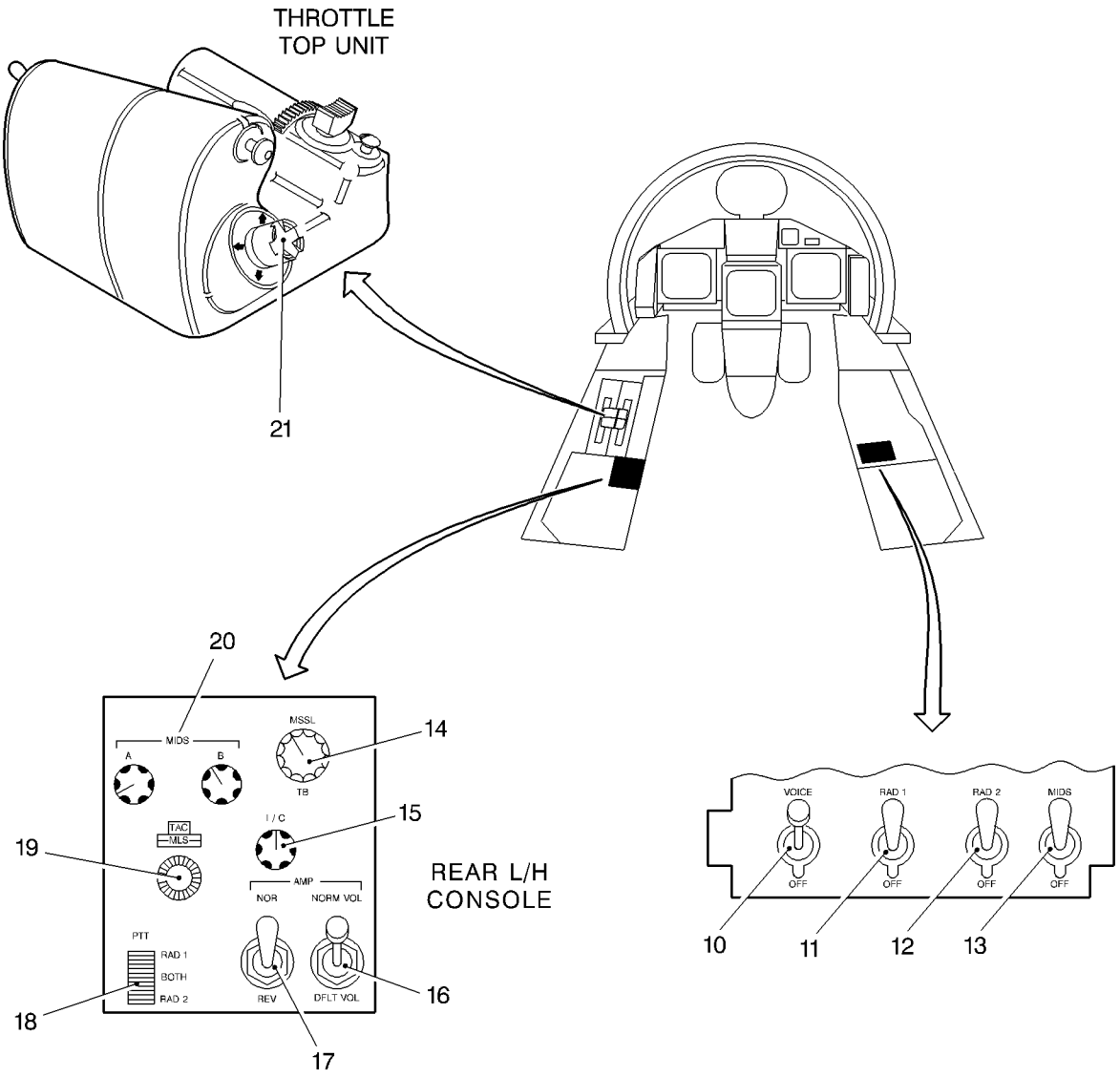
When the MHDD/Radio format is first selected it will display the page containing the channel currently selected on Radio 1. The pilot is able to use the X-Y controller to select for display the frequency channels lists for either Radio 1 or Radio 2 by performing an X-Y insert over the relevant RADIO channel icon. Alternatively he can select the RAD1/ RAD2 SK. When the radio frequency channel list is changed, the X-Y marker is automatically re-positioned over the page change icon.

At any one time only half of the list of channels for the selected radio is displayed. The currently selected channel is highlighted by a green box. As the channel selector on the HUP is rotated the box moves to highlight the appropriate channel. If a channel is selected that is not currently on that page, the page featuring the channel will automatically be presented with the highlight box around the appropriate channel.The pilot may also pageeither the RADIO 1 or RADIO 2 channels lists to display the half of the list not currently shown by performing an X-Y insert over the page change icon. Alternatively he can select the PAGE UP or PAGE DOWN SK to achieve the same result.



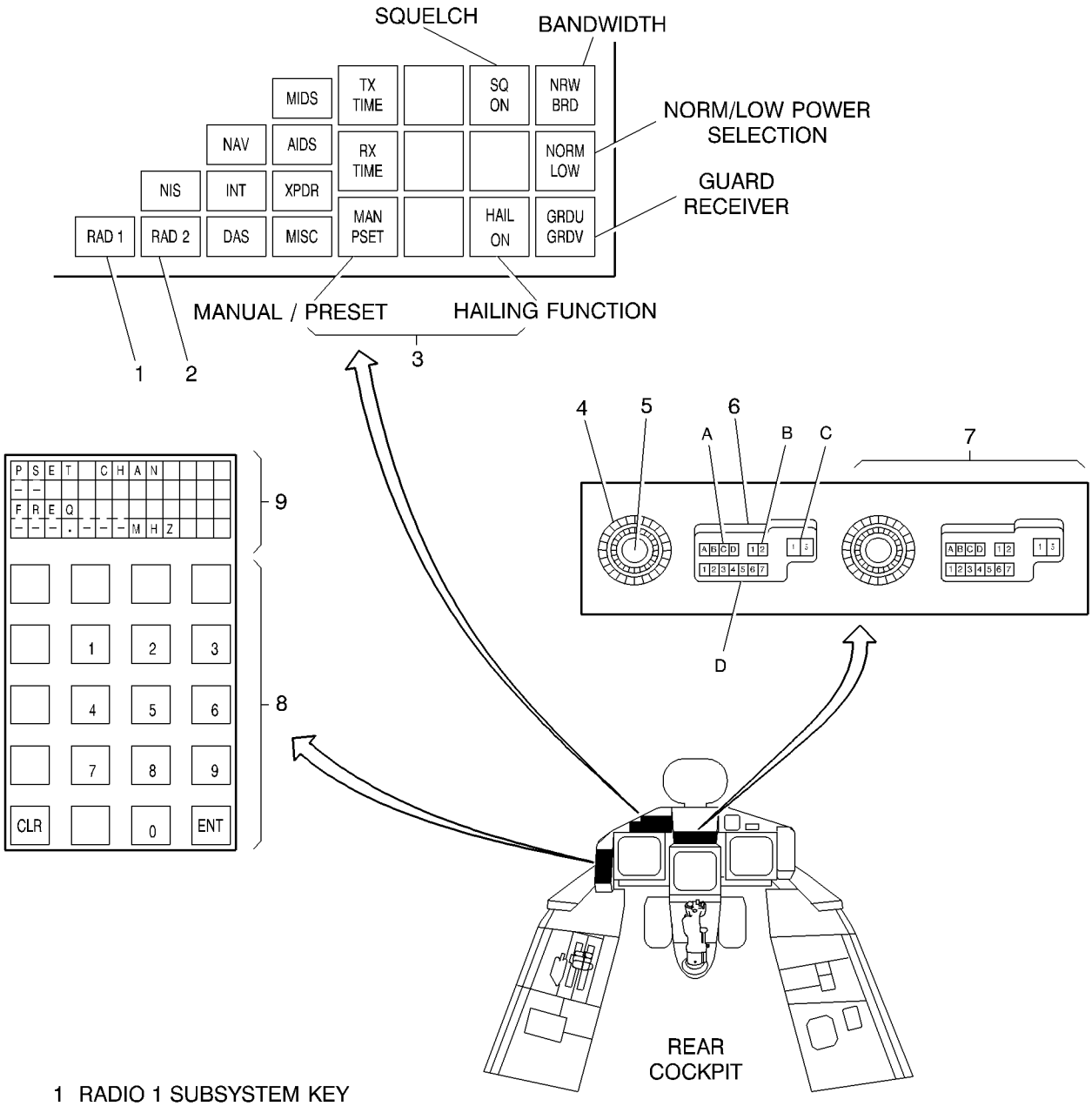
1 RADIO 1 SUBSYSTEM KEY
2 RADIO 2 SUBSYSTEM KEY
3 MODING KEYS
4 RADIO 1 VOLUME CONTROL
5 RADIO 1 CHANNEL SELECTOR KNOB
6 RADIO 1 READOUT DISPLAY
A. OPERATING MODE
B. ENABLED GUARD MODE & TRANSMIT / RECEIVE
C. SELECTED CHANNEL DISPLAY
D. FREQUENCY ASSOCIATED TO THE SELECTED CHANNEL
7 SIMILAR TO ITEM 4 TO 6 FOR RADIO 2
8 DATA ENTRY KEYBOARD
9 READOUT LINES

Figure 1.197 - Communication Equipment - Controls and Indications (Sheet 1 of 2)



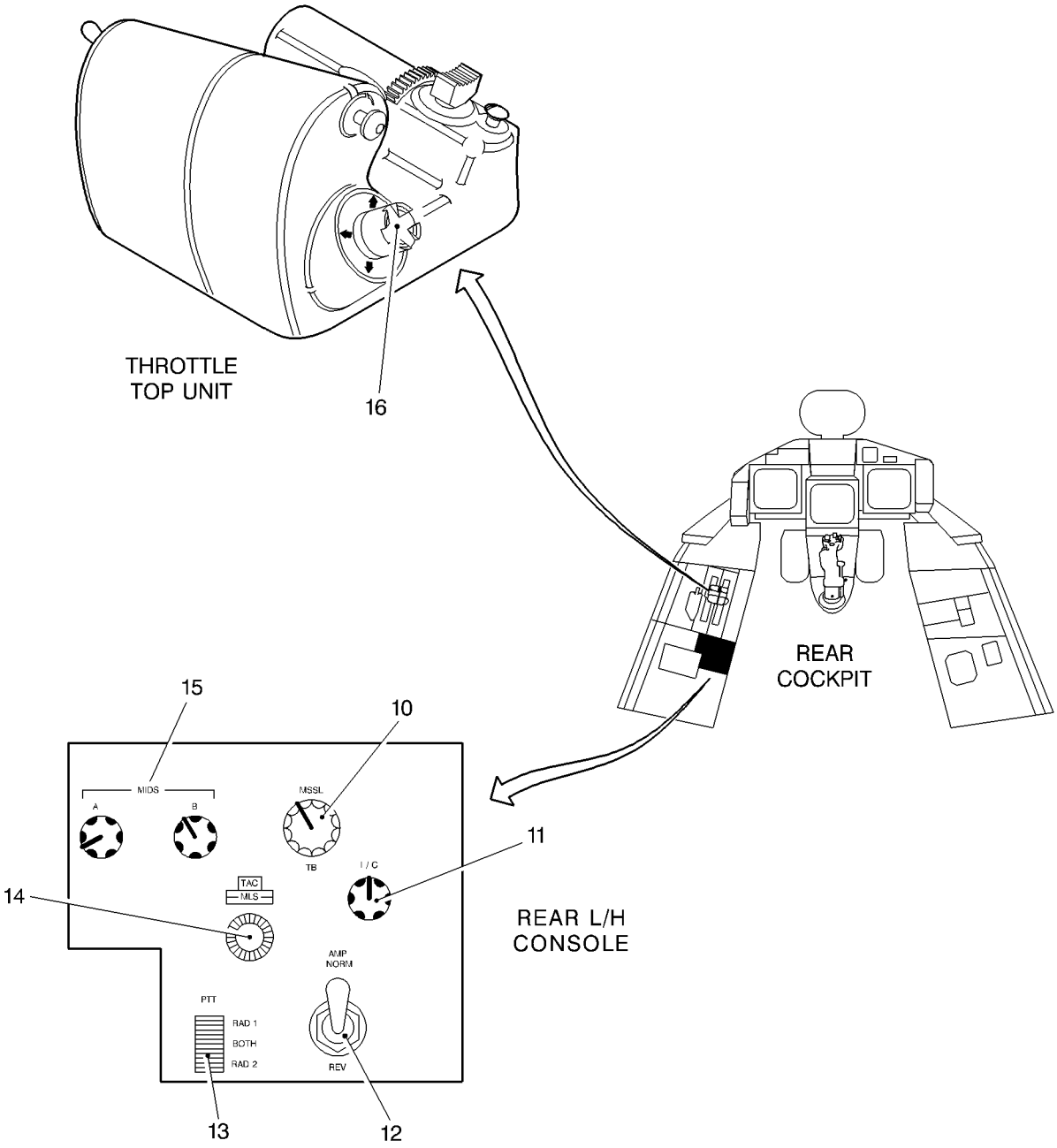
10 VOICE WARNING CONTROL SWITCH
11 RADIO 1 TRANSMIT SWITCH
12 RADIO 2 TRANSMIT SWITCH
13 MIDS SWITCH
14 MISSILE TONES & TELEBRIEF CONTROLS
15 INTERCOM VOLUME CONTROL
16 DEFAULT VOLUME SELECTOR SWITCH
17 AMPLIFIER SELECTOR SWITCH
18 DUPLICATE PTT SWITCH
19 TACAN & MLS VOLUME CONTROLS
20 MIDS A / B CONTROLS
21 COMMUNICATION CONTROL SWITCH

Figure 1.197 - Communication Equipment - Controls and Indications (Sheet 2 of 2)



1 RADIO 1 SUBSYSTEM KEY
2 RADIO 2 SUBSYSTEM KEY
3 MODING KEYS
4 RADIO 1 VOLUME CONTROL
5 RADIO 1 CHANNEL SELECTOR KNOB
6 RADIO 1 READOUT DISPLAY
A. OPERATING MODE
B. ENABLED GUARD MODE & TRANSMIT / RECEIVE
C. SELECTED CHANNEL DISPLAY
D. FREQUENCY ASSOCIATED TO THE SELECTED CHANNEL
7 SIMILAR TO ITEM 4 TO 6 FOR RADIO 2
8 DATA ENTRY KEYBOARD
9 READOUT LINES

Figure 1.198 - Communication Equipment - Rear Cockpit - Controls and Indications (Sheet 1 of 2)



10 MISSILE TONES & TELEBRIEF CONTROLS
11 INTERCOM VOLUME CONTROL
12 AMPLIFIER SELECTOR SWITCH
13 DUPLICATE PTT SWITCH
14 TACAN & MLS VOLUME CONTROLS
15 MIDS A / B CONTROLS
16 COMMUNICATION CONTROL SWITCH

Figure 1.198 - Communication Equipment - Rear Cockpit - Controls and Indications (Sheet 2 of 2)

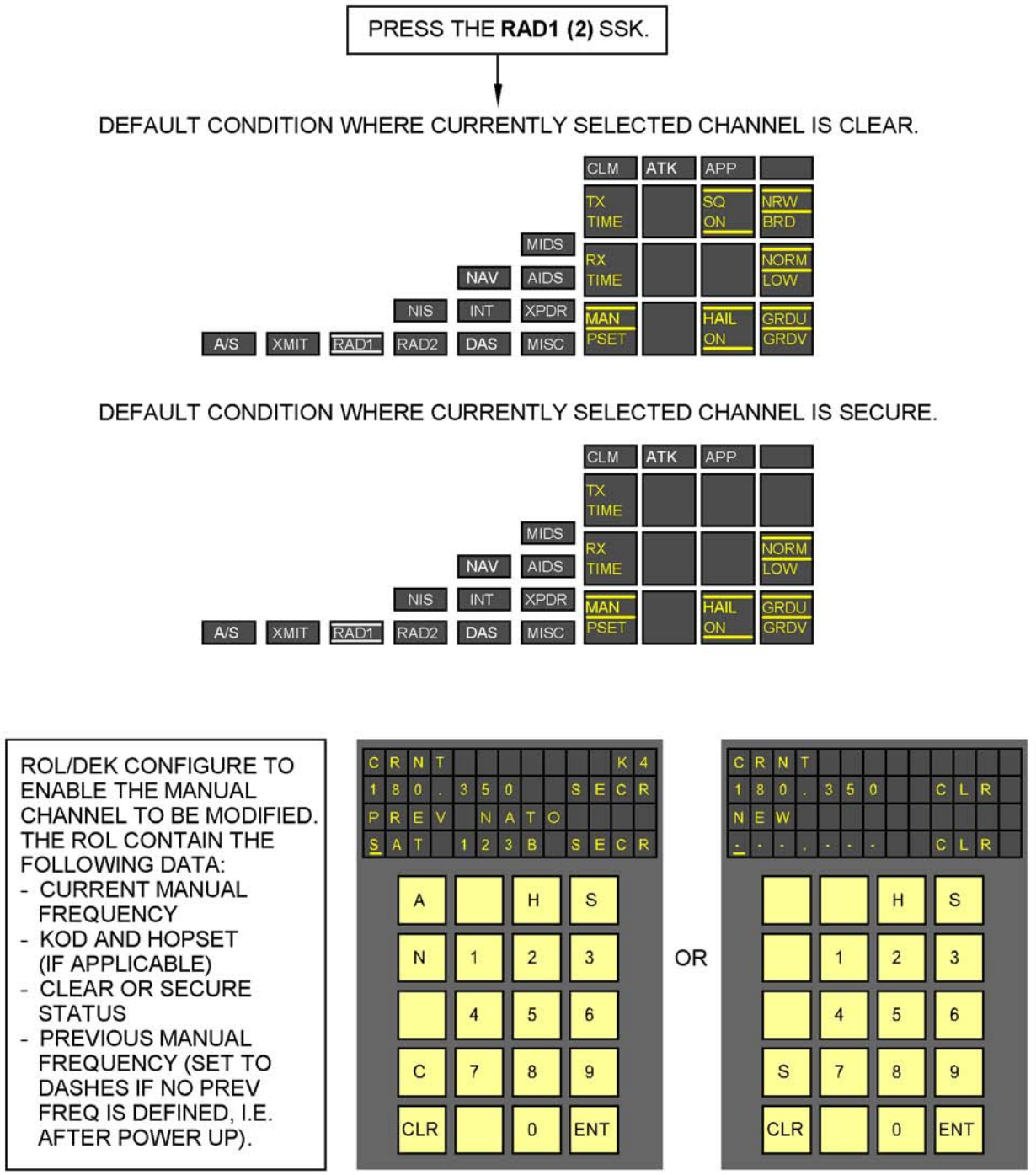


Figure 1.199 - Default Moding of Radio 1 (2) Subsystem

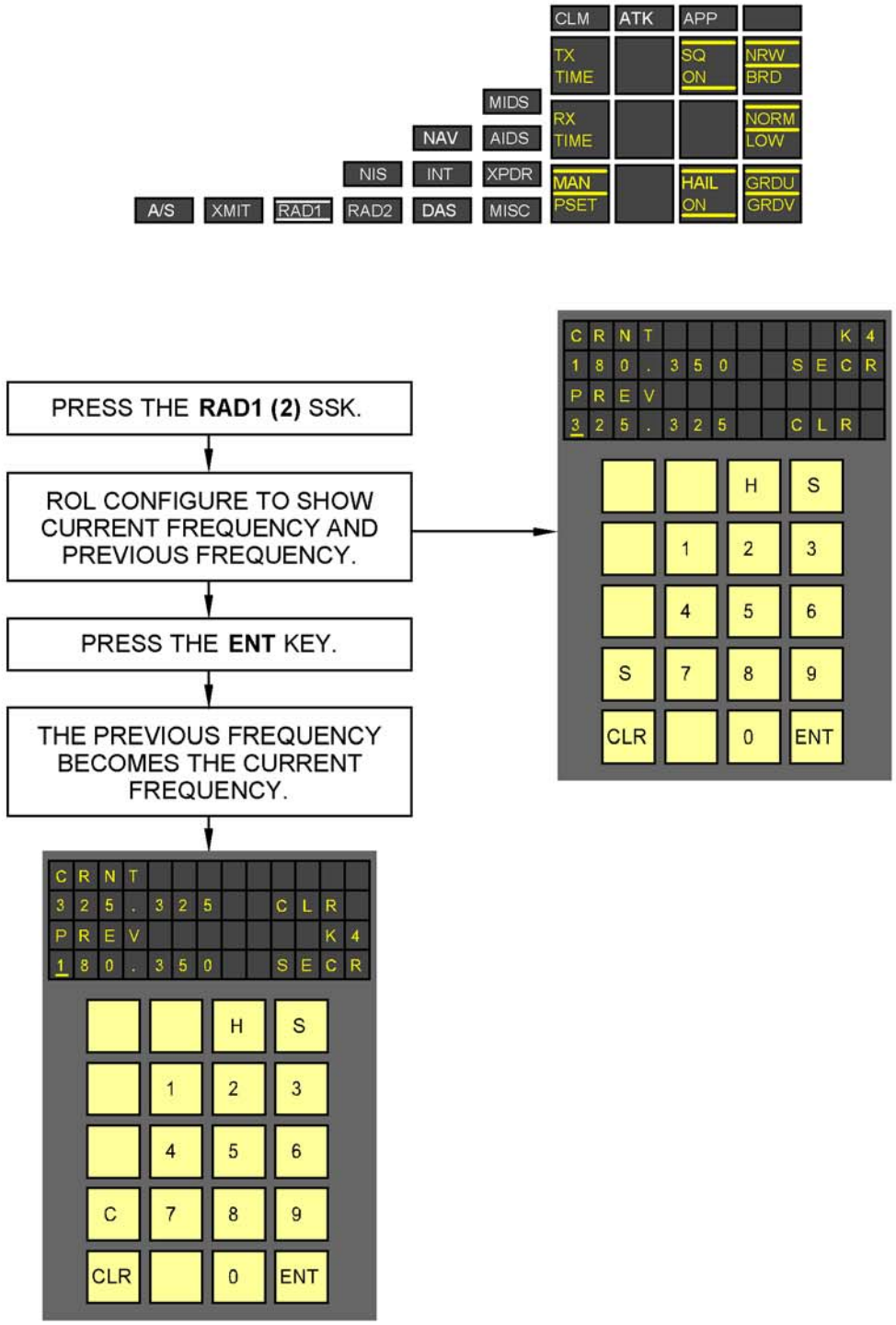


Figure 1.200 - Edit Manual Channel - Selecting Previous Frequency

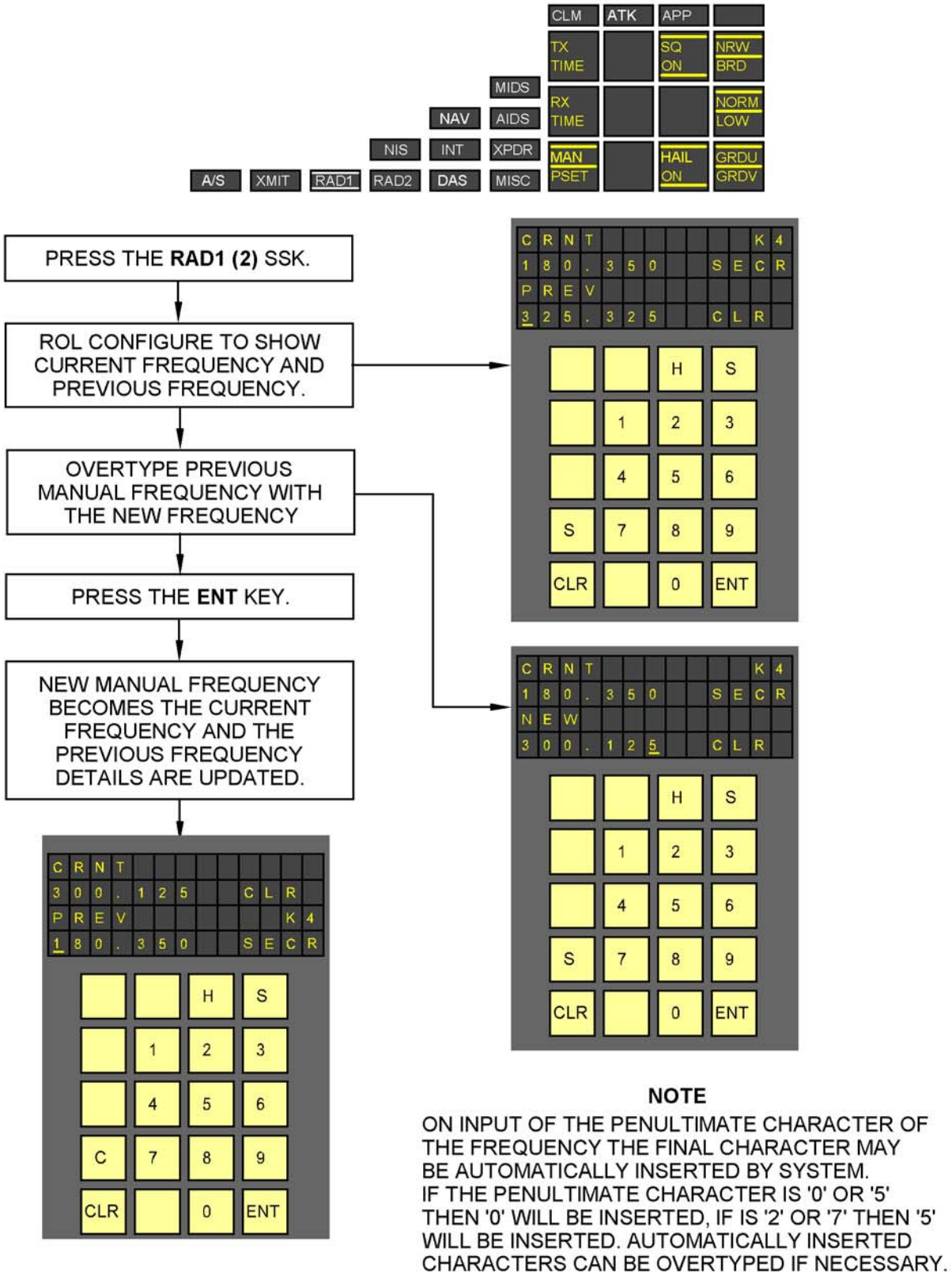


Figure 1.201 - Edit Manual Channel - Input New Frequency

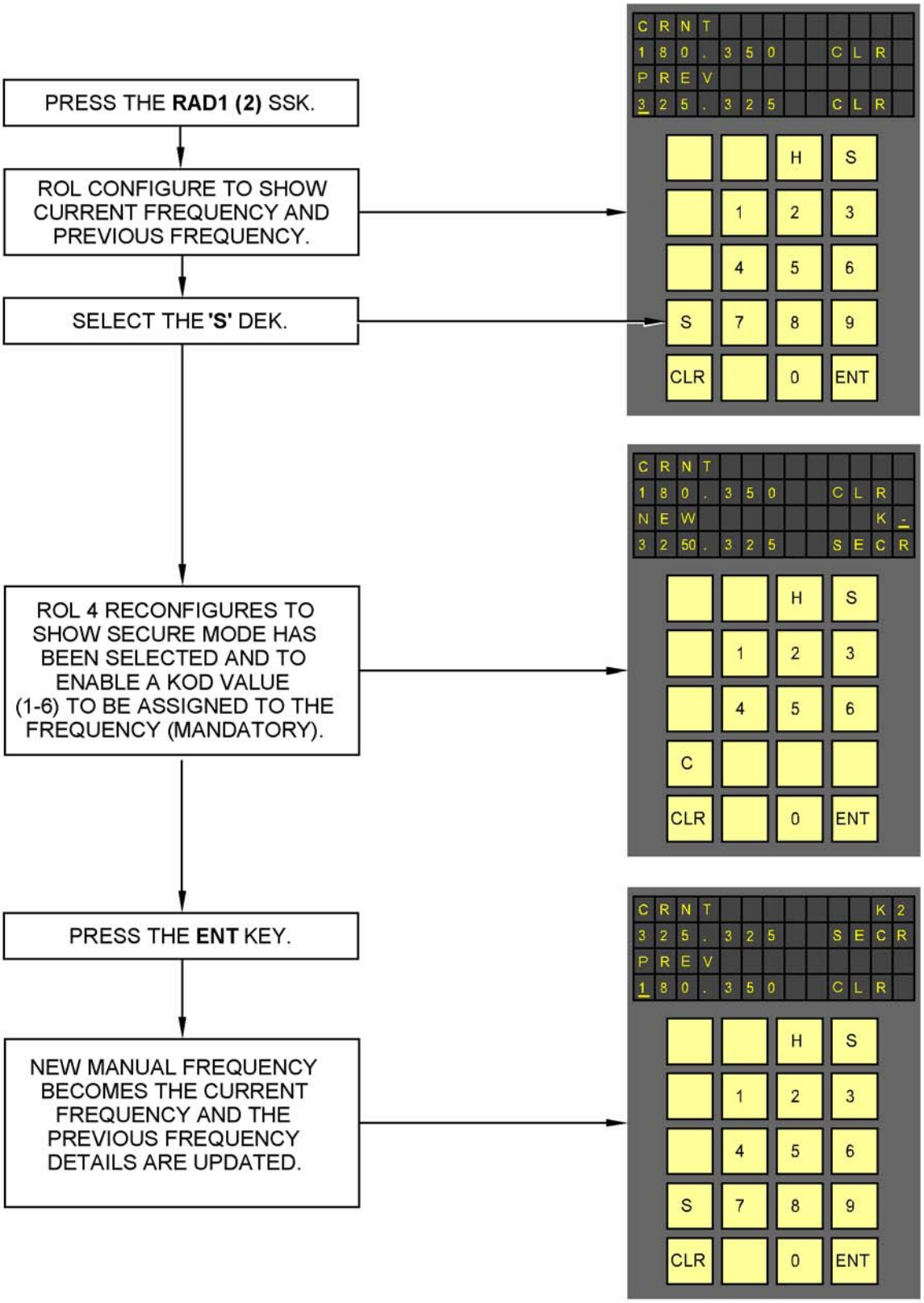

PRESS THE RAD1 (2) SSK.
ROL CONFIGURE TO SHOW CURRENT FREQUENCY AND PREVIOUS FREQUENCY.
SELECT THE 'S' DEK.
ROL 4 RECONFIGURES TO SHOW SECURE MODE HAS BEEN SELECTED AND TO ENABLE A KOD VALUE (1-6) TO BE ASSIGNED TO THE FREQUENCY (MANDATORY).
PRESS THE ENT KEY.
NEW MANUAL FREQUENCY BECOMES THE CURRENT FREQUENCY AND THE PREVIOUS FREQUENCY DETAILS ARE UPDATED.
CRNT
180.350 CLR
PREV
325.325 CLR
NEW
325 0.325 SECR
K -
K 2
H S
1 2 3
4 5 6
S 7 8 9
C
CLR 0 ENT

Figure 1.202 - Edit Manual Channel - Selecting Between Secure and Clear Modes/Inputting KOD Value

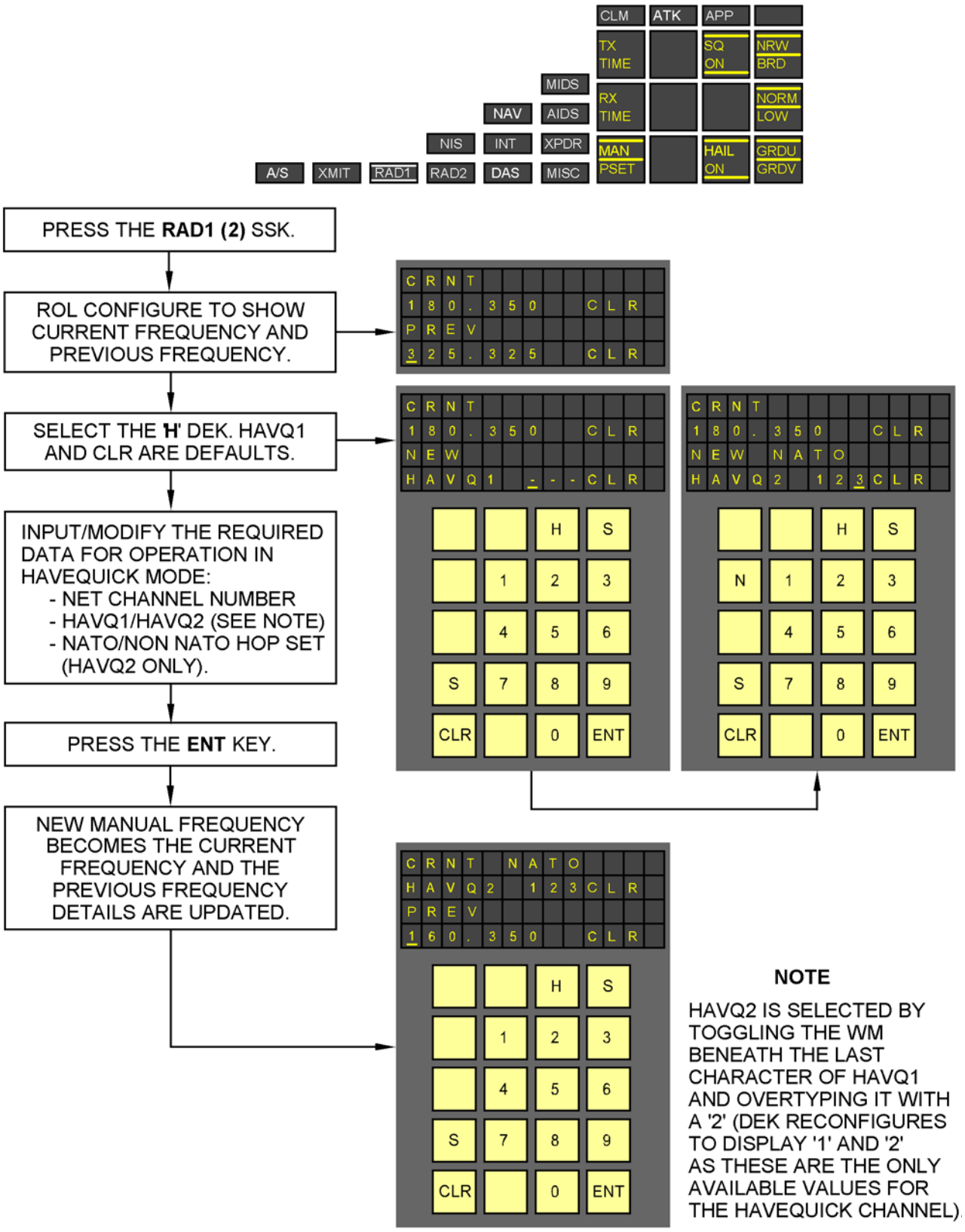

CLM
ATK
APP
TX TIME
SQ ON
NRW BRD
MIDS
RX TIME
NORM LOW
NAV
AIDS
NIS
INT
XPDR
MAN PSET
HAIL ON
GRDU GRDV
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE RAD1 (2) SSK.
ROL CONFIGURE TO SHOW CURRENT FREQUENCY AND PREVIOUS FREQUENCY.
SELECT THE 'H' DEK. HAVQ1 AND CLR ARE DEFAULTS.
INPUT/MODIFY THE REQUIRED DATA FOR OPERATION IN HAVEQUICK MODE:
- NET CHANNEL NUMBER
- HAVQ1/HAVQ2 (SEE NOTE)
- NATO/NON NATO HOP SET (HAVQ2 ONLY).
PRESS THE ENT KEY.
NEW MANUAL FREQUENCY BECOMES THE CURRENT FREQUENCY AND THE PREVIOUS FREQUENCY DETAILS ARE UPDATED.
CRNT 180.350 CLR
PREV 325.325 CLR
CRNT 180.350 CLR
NEW HAVQ1 - - - CLR
CRNT 180.350 CLR
NEW NATO HAVQ2 123 CLR
H S 1 2 3 4 5 6 S 7 8 9 CLR 0 ENT
N
CRNT NATO HAVQ2 123 CLR
PREV 160.350 CLR
NOTE
HAVQ2 IS SELECTED BY TOGGLING THE WM BENEATH THE LAST CHARACTER OF HAVQ1 AND OVERTYPING IT WITH A '2' (DEK RECONFIGURES TO DISPLAY '1' AND '2' AS THESE ARE THE ONLY AVAILABLE VALUES FOR THE HAVEQUICK CHANNEL)

Figure 1.203 - Edit Manual Channel - Selecting Havequick

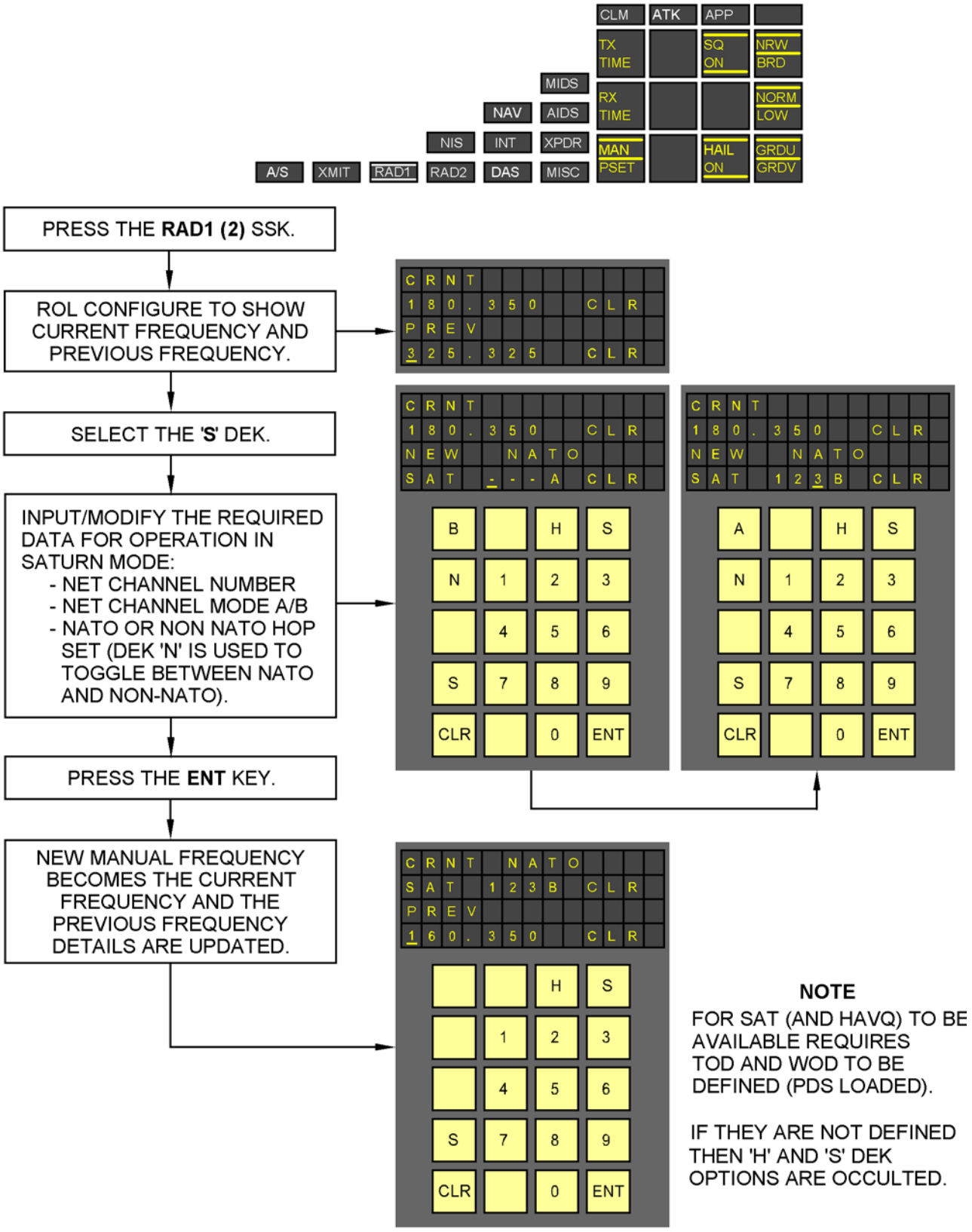

CLM
ATK
APP
TX TIME
SQ ON
NRW BRD
MIDS
RX TIME
NORM LOW
NAV
AIDS
NIS
INT
XPDR
MAN PSET
HAIL ON
GRDU GRDV
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE RAD1 (2) SSK.
ROL CONFIGURE TO SHOW CURRENT FREQUENCY AND PREVIOUS FREQUENCY.
CRNT 180.350 CLR
PREV 325.325 CLR
SELECT THE 'S' DEK.
INPUT/MODIFY THE REQUIRED DATA FOR OPERATION IN SATURN MODE:
- NET CHANNEL NUMBER
- NET CHANNEL MODE A/B
- NATO OR NON NATO HOP SET (DEK 'N' IS USED TO TOGGLE BETWEEN NATO AND NON-NATO).
CRNT 180.350 CLR NEW NATO SAT - - - A CLR
CRNT 180.350 CLR NEW NATO SAT 123B CLR
B H S N 1 2 3 4 5 6 S 7 8 9 CLR 0 ENT
A H S N 1 2 3 4 5 6 S 7 8 9 CLR 0 ENT
PRESS THE ENT KEY.
NEW MANUAL FREQUENCY BECOMES THE CURRENT FREQUENCY AND THE PREVIOUS FREQUENCY DETAILS ARE UPDATED.
CRNT NATO SAT 123B CLR PREV 160.350 CLR
H S 1 2 3 4 5 6 S 7 8 9 CLR 0 ENT
NOTE
FOR SAT (AND HAVQ) TO BE AVAILABLE REQUIRES TOD AND WOD TO BE DEFINED (PDS LOADED).
IF THEY ARE NOT DEFINED THEN 'H' AND 'S' DEK OPTIONS ARE OCCULTED.

Figure 1.204 - Edit Manual Channel - Selecting Saturn

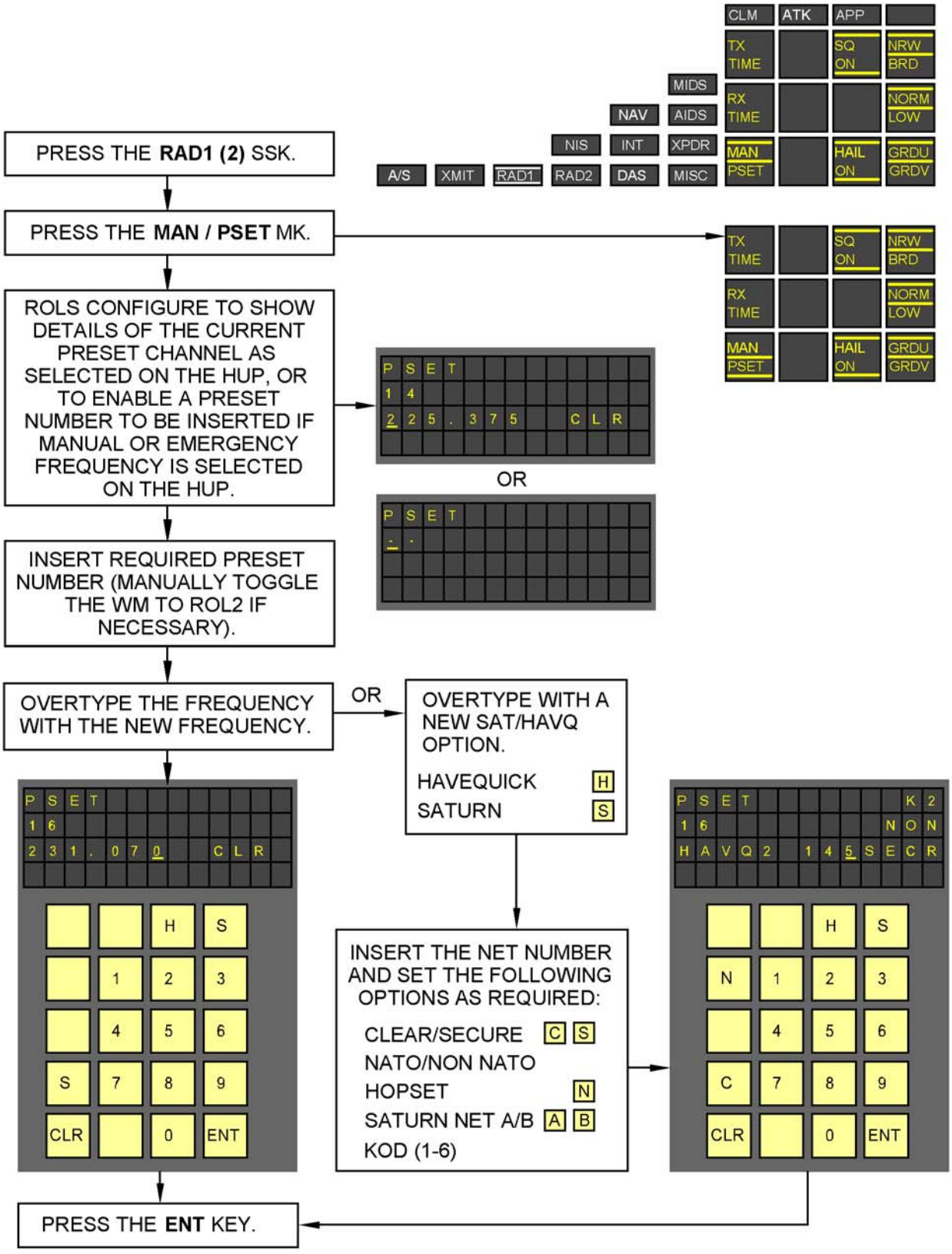


Figure 1.205 - Edit Preset Channel

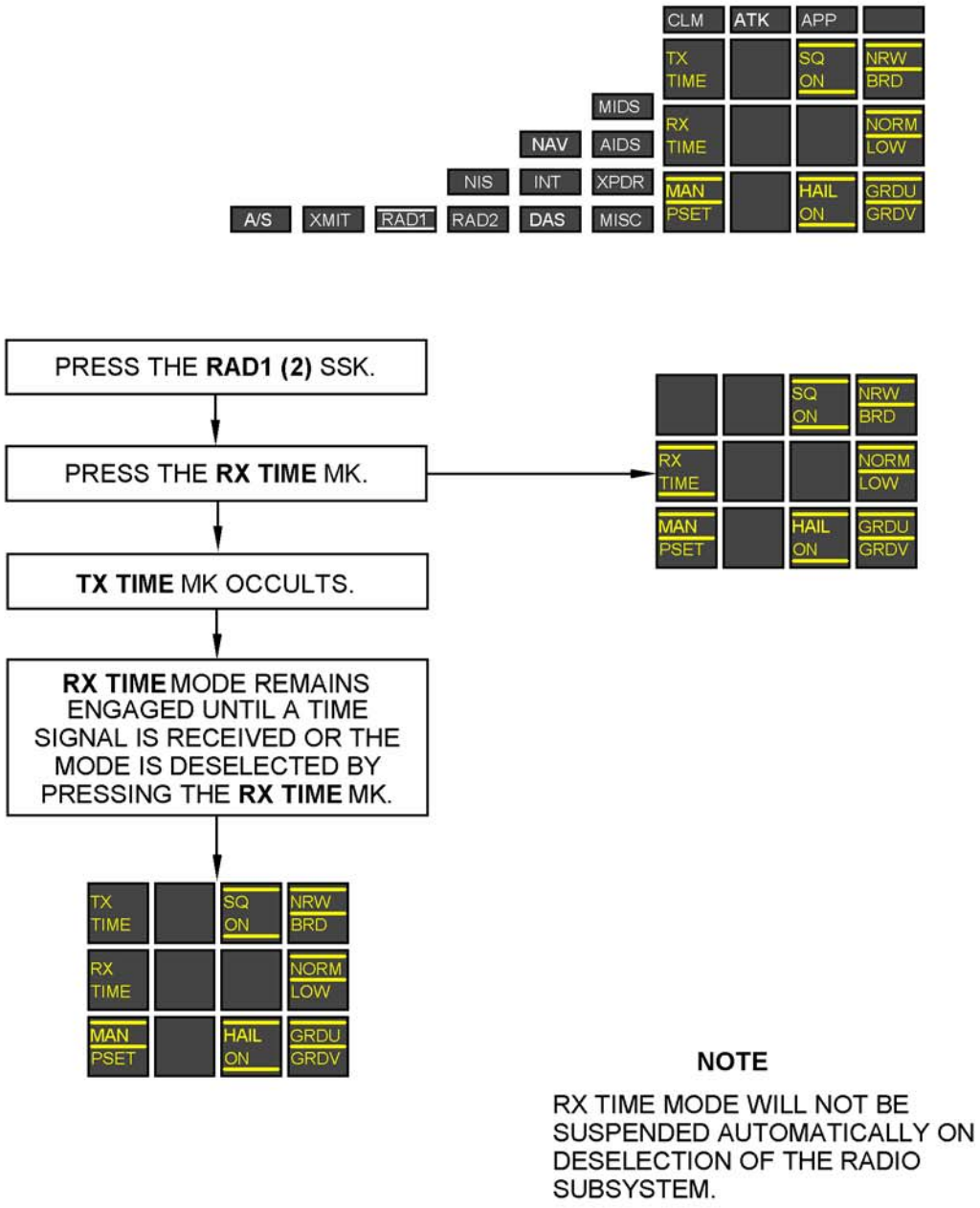


Figure 1.206 - Receiving Time Mode

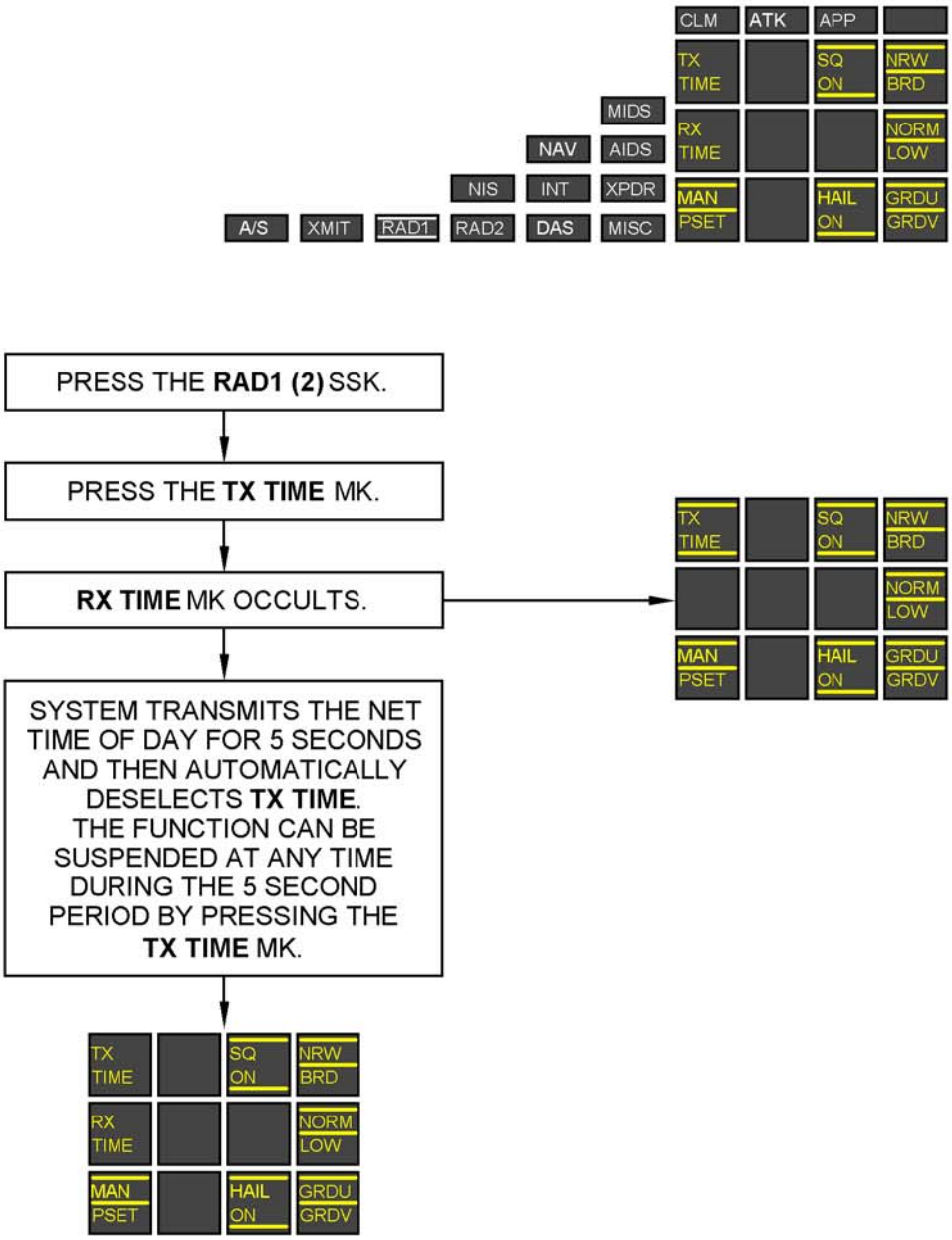


Figure 1.207 - Transmitting Time Mode

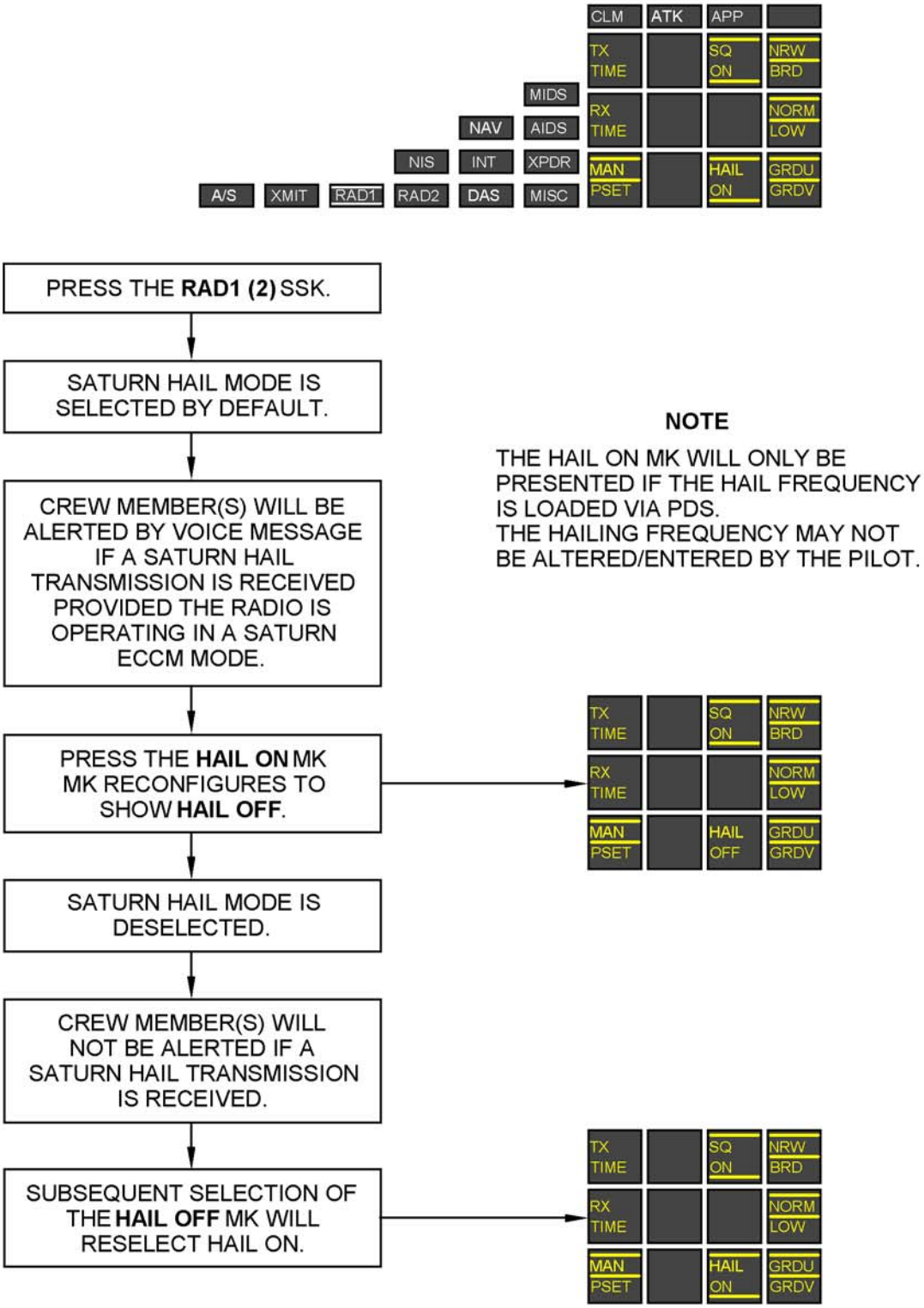


Figure 1.208 - Selecting/Deselecting Saturn Hail

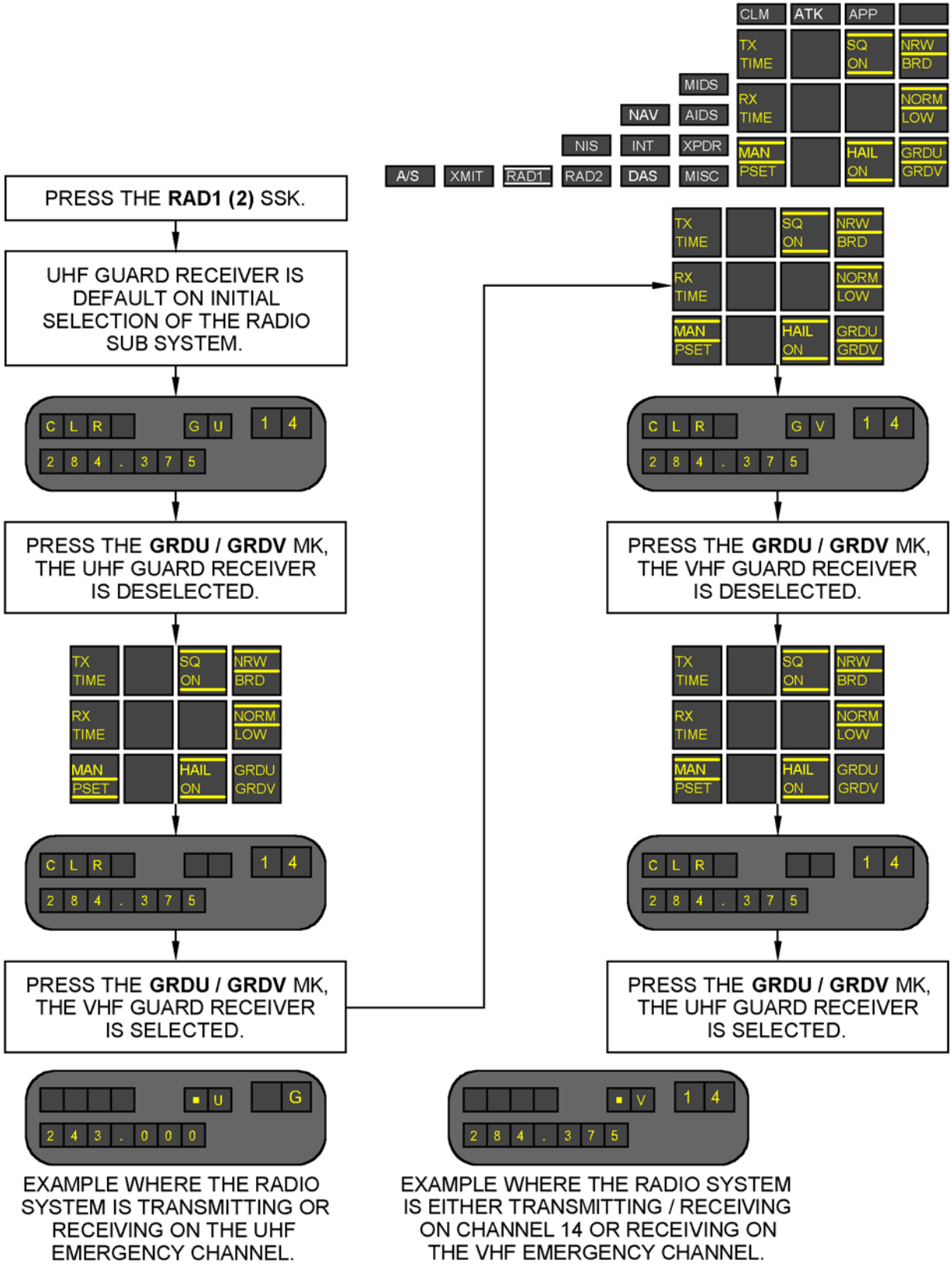
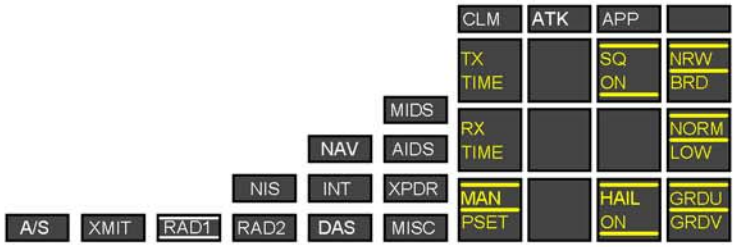

PRESS THE RAD1 (2) SSK.
UHF GUARD RECEIVER IS DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.
PRESS THE GRDU / GRDV MK, THE UHF GUARD RECEIVER IS DESELECTED.
PRESS THE GRDU / GRDV MK, THE VHF GUARD RECEIVER IS SELECTED.
PRESS THE GRDU / GRDV MK, THE VHF GUARD RECEIVER IS DESELECTED.
PRESS THE GRDU / GRDV MK, THE UHF GUARD RECEIVER IS SELECTED.
CLM
ATK
APP
TX TIME
SQ ON
NRW BRD
RX TIME
NORM LOW
MAN PSET
HAIL ON
GRDU GRDV
MIDS
NAV
AIDS
NIS
INT
XPDR
A/S
XMIT
RAD1
RAD2
DAS
MISC
C L R
G U
G V
1 4
2 8 4 . 3 7 5
2 4 3 . 0 0 0
EXAMPLE WHERE THE RADIO SYSTEM IS TRANSMITTING OR RECEIVING ON THE UHF EMERGENCY CHANNEL.
EXAMPLE WHERE THE RADIO SYSTEM IS EITHER TRANSMITTING / RECEIVING ON CHANNEL 14 OR RECEIVING ON THE VHF EMERGENCY CHANNEL.

Figure 1.209 - Guard Receiver Mode Selection



PRESS THE **RAD1 (2)** SSK.

NARROW BANDWIDTH MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.

PRESS THE **NRW/BRD** MK.

BROAD BAND MODE IS SELECTED

NARROW BANDWIDTH MODE CAN BE RESELECTED BY PRESSING THE **NRW/BRD** MK.

NOTE

THE **NRW/BRD** MK IS ONLY AVAILABLE FOR SELECTION IN HAVEQUICK CLEAR AND FIXED FREQUENCY CLEAR VOICE MODE (SATURN AND SECURE MODES REQUIRE BROAD BANDWIDTH ONLY).

Figure 1.210 - Selecting Bandwidth

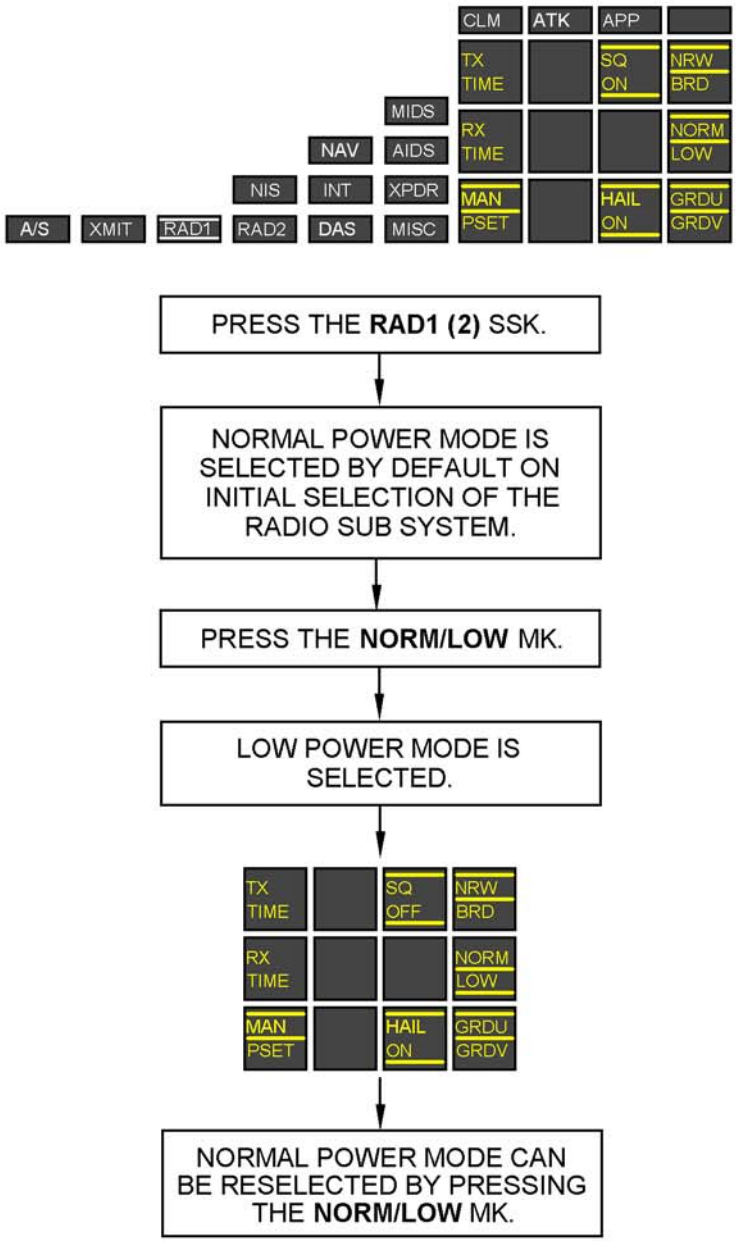
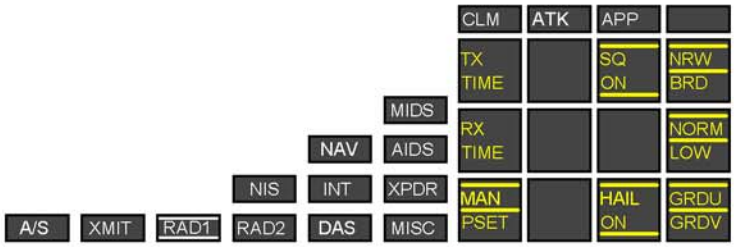


Figure 1.211 - Selecting Transmitter Power



PRESS THE **RAD1 (2)** SSK.

SQUELCH MODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE RADIO SUB SYSTEM.

PRESS THE **SQ ON** MK.

SQUELCH MODE IS DESELECTED AND THE MK RECONFIGURES TO SHOW **SQ OFF**.

SQUELCH MODE CAN BE RESELECTED BY PRESSING THE **SQ OFF** MK.

NOTE

THE **SQ ON/OFF** MK IS NOT PRESENTED IN CONJUNCTION WITH THE FOLLOWING SECURE RADIO OPTIONS:

- FIXED FREQUENCY SECURE
- HAVEQUICK SECURE
- SATURN

THESE OPTIONS AUTOMATICALLY SELECT SQUELCH TO ON.

Figure 1.212 - Selecting Squelch Mode

SELECT THE RADIO FORMAT ON THE MHDD VIA THE FREQ SOFT KEY.
RADIO 1 PRESETS ARE PRESENTED ON THE MHDD AND CURRENTLY SELECTED RADIO CHANNEL IS BOXED.
CHKL
RAD1
RAD2
PAGE DOWN
ELEV
NORM
DASS
HUD
STOR
FUEL
ENG
HYD
WPT
FREQ
RAD 1
RAD 2
01 352.750 CLR WTN GND
02 254.350 CLR WTN TWR
03 383.850 CLR WTN SRE
04 286.750 CLR WTN APR
05 226.600 CLR
06 244.740 SECR 1 COM MON
07 365.350 CLR
08 255.650 SECR 2 CTR 001
09 256.700 SECR 3 ACI 001
10 257.850 SECR 4 ACI 002
11 258.900 SECR 5 ACI 003
12 260.150 SECR 6 AAR 001
M1 144.000 CLR
M2 127.000 CLR
CLICK ON PAGE ICON WITH THE X-Y CONTROLLER OR PRESS THE PAGE DOWN SOFT KEY TO ACCESS THE NEXT PAGE.
CLICK ON THE RAD2 ICON WITH THE X-Y CONTROLLER OR PRESS THE RAD1 RAD2 SOFT KEY TO ACCESS THE RAD2 PRESETS.
01 383.850 CLR WTN SRE
02 244.740 SECR 1 COM MON
03 286.750 CLR WTN APR
04 258.900 SECR 5 ACI 003
05 257.850 SECR 4 ACI 002
06 260.150 SECR 6 AAR 001
07 383.850 CLR WTN SRE
08 255.650 SECR 2 CTR 001
09 256.700 SECR 3 ACI 001
10 254.350 CLR WTN TWR
11 352.750 CLR WTN GND
12 365.350 CLR
M1 144.000 CLR
M2 127.000 CLR

Figure 1.213 - Browse Radio List

WARNING EQUIPMENT

Audio Warning Equipment

(1B-B-31-50-10-00A-043A-A Issue 004)

Introduction

The Communications and Audio Management Unit (CAMU) provides and controls the communications. When a failure occurs to which the crew need alerting, the relevent system sends the warning to the master CSG, where it is categorized and prioritized. The CSG outputs the warnings to the Dedicated Warning Panel (DWP), triggers the attention getters and CAMU to output the necessary attensons and voice warnings.

Voice Warning System Mute Control

Voice warnings can be suspended by selecting Voice Warning Suspend (VWS) on the communication control switch, located on the right throttle top, Figure 1.214. If the VWS switch is pressed and released the suspended warning, and all warnings of equal or lower priority, are suspended for a period of 15 seconds. However if the VWS switch is pressed and held for >15 seconds then the suspended warning, and all warnings of equal or lower priority, are suspended for the duration of the switch press. During VWS, warnings of higher priority than the currently suspended warnings are unaffected by VWS suspension. Catastrophic warnings cannot be suspended. Voice warnings, except catastrophic warnings, can be disabled by selecting OFF at the voice warning audio control to the rear of the right console, Figure 1.214 .

VWS is not available in rear cockpit.

Press to Transmit

There are two Press to Transmit (PTT) controls; one on the right throttle top (communication control switch) and one on the left console (Figure 1.214). Radio transmission causes transmission of audio warnings to be suspended. If a warning message has started to play, selecting the PTT control suspends the warning for the duration that PTT is selected; the warning continues upon de-escalation of the PTT control. If a warning occurs after the control is selected, the message plays immediately.

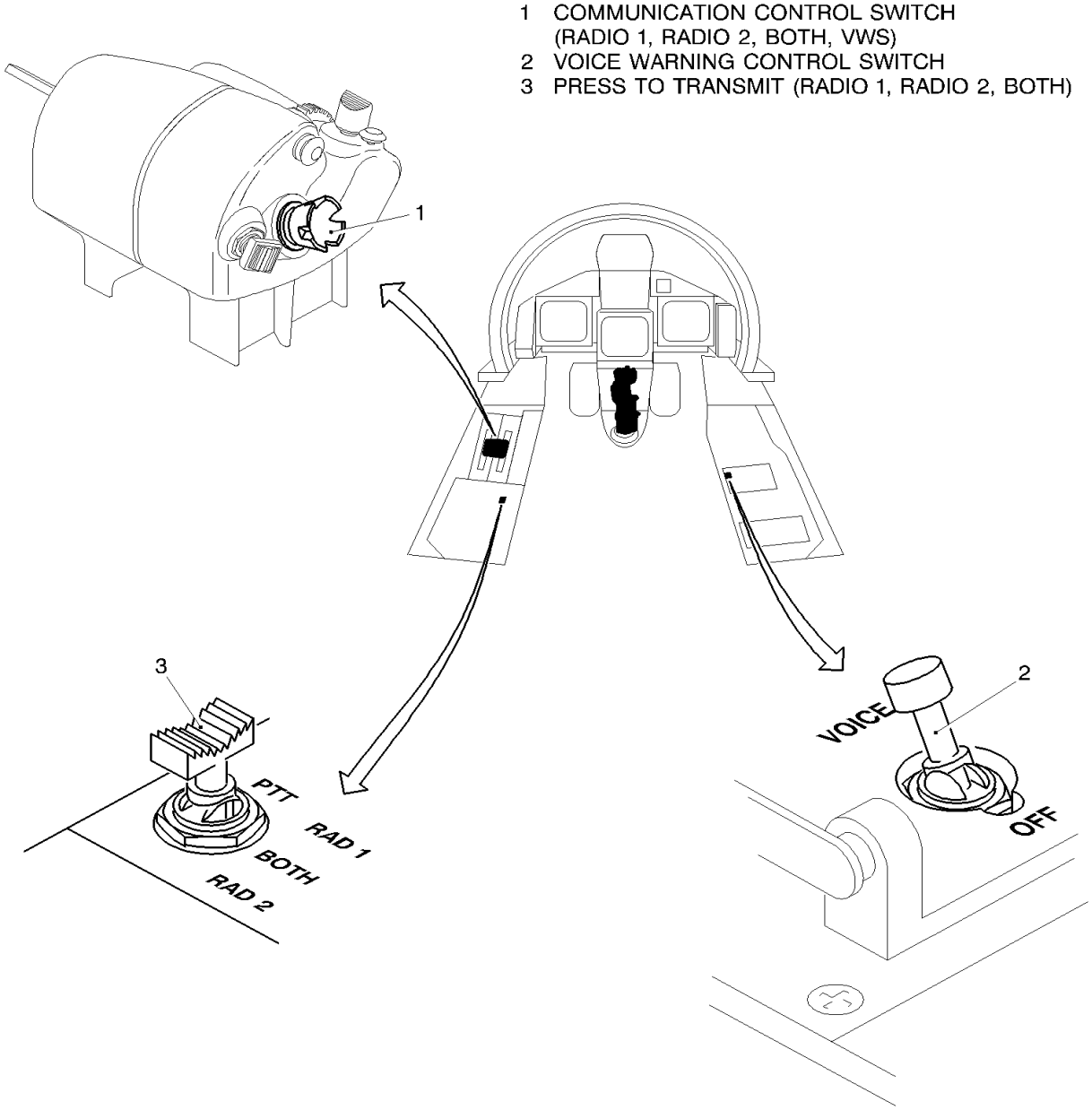


Figure 1.214 - Cockpit Audio Warning Controls

Warnings Management and Failure Analysis

(1B-B-31-50-20-00A-043A-A Issue 004)

Introduction

Under normal operating conditions, all on-aircraft systems are automatically monitored for failures. Failures that directly affect aircraft operation or require pilot compensation or corrective action are warned to the pilot through the warning system. Failures that do not directly affect aircraft operation are not warned to the pilot, but are recorded through the Integrated Monitoring and Recording System (IMRS) for subsequent investigation and fault analysis.

The warnings system prioritizes all existing warnings and presents them to the aircrew in an organized and consistent manner. The warnings are presented by some, or all of the following devices: flashing attention getters, a caption on the Dedicated Warnings Panel (DWP), an attention getting sound (attenson) and a voice warning message. The aural components of the warning are generated by the Communications and Audio Management System (CAMU).

All warnings are either related to aircraft systems or are of a procedural nature and are assigned a category according to the POF, and are also prioritized within each category. The categories are Catastrophic, 1, 2, 3 and 4 in descending order of priority. Warnings occurring simultaneously will be presented sequentially according to their category and prioritization.

During start-up/shutdown, warnings are suppressed to prevent an array of warnings due to inactive equipment or systems.

Warnings generated as a consequence of a primary fault condition are referred to as secondary warnings and they are presented on the DWP but do not trigger any other part of the warnings system.

Catastrophic Warnings

A catastrophic failure is an event which makes it impossible for the aircraft to continue safe flight and handling. Immediate pilot action is advised which, under some circumstances, may be immediate ejection.

Category 1 Warnings

A category 1 warning is of a procedural nature and warns of a hazardous situation that requires immediate action.

Upon receipt of a category 1 warning, the attention getters flash and the voice warning message is heard. Pressing one of the attention getters acknowledges the warning; the attention getters stop flashing and, if it is the first play of the voice message, the voice warning is allowed to play in full and then ceases. For subsequent plays, the message stops immediately. Figure 1.215 illustrates this sequence.

NOTE

The voice warning message interrupts and mutes any incoming audio communications.

Category 2 Warnings

A category 2 warning is related to aircraft systems and warns of a primary failure that requires immediate action.

Upon receipt of a category 2 warning, the attention getters and the related DWP red caption flash, and an attenson is heard, which is followed by a voice warning message. By pressing one of the attention getters, the attention getters stop flashing and the flashing DWP caption becomes steady. If it is the first play of the voice message, it is allowed to play in full, and then ceases. For subsequent plays, it stops playing immediately; Figure 1.216 illustrates this sequence.

NOTE

The attenson interrupts and mutes any incoming audio communications, the voice warning message operates in parallel with any incoming communications.

Category 3 Warnings

A category 3 warning is also related to aircraft systems and warns of a primary failure that requires attention.

Upon receipt of a category 3 warning, the attention getters and the related DWP amber caption flash, and voice warning message is heard. By pressing one of the attention getters, the attention getters stop flashing and the flashing DWP amber caption becomes steady. If it is the first play of the voice message, it is allowed to play in full, and then ceases. For subsequent plays, it stops immediately. Figure 1.217 illustrates this sequence.

NOTE

The voice warning message operates in parallel with any incoming audio communications.

Category 4 Warnings

A category 4 warning is procedural only and provides advice or information of a procedural nature.
Upon receipt of a category 4 warning, a voice warning message is played twice and then stops. It can also be stopped by pressing one of the attention getters (even though they are not flashing - not active for this category of warning).
There are no DWP warning indications for a Category 4 warning.

NOTE

The message operates in parallel with any incoming audio communications.

Get-U-Home Warnings

The GUH warnings are all category 2, except for one (CPT DISP) which is category 3. They are presented to the pilot as described for other category 2 and 3 warnings. For more information on GUH warnings, refer to Get-U-Home Warnings pag. 1-446.

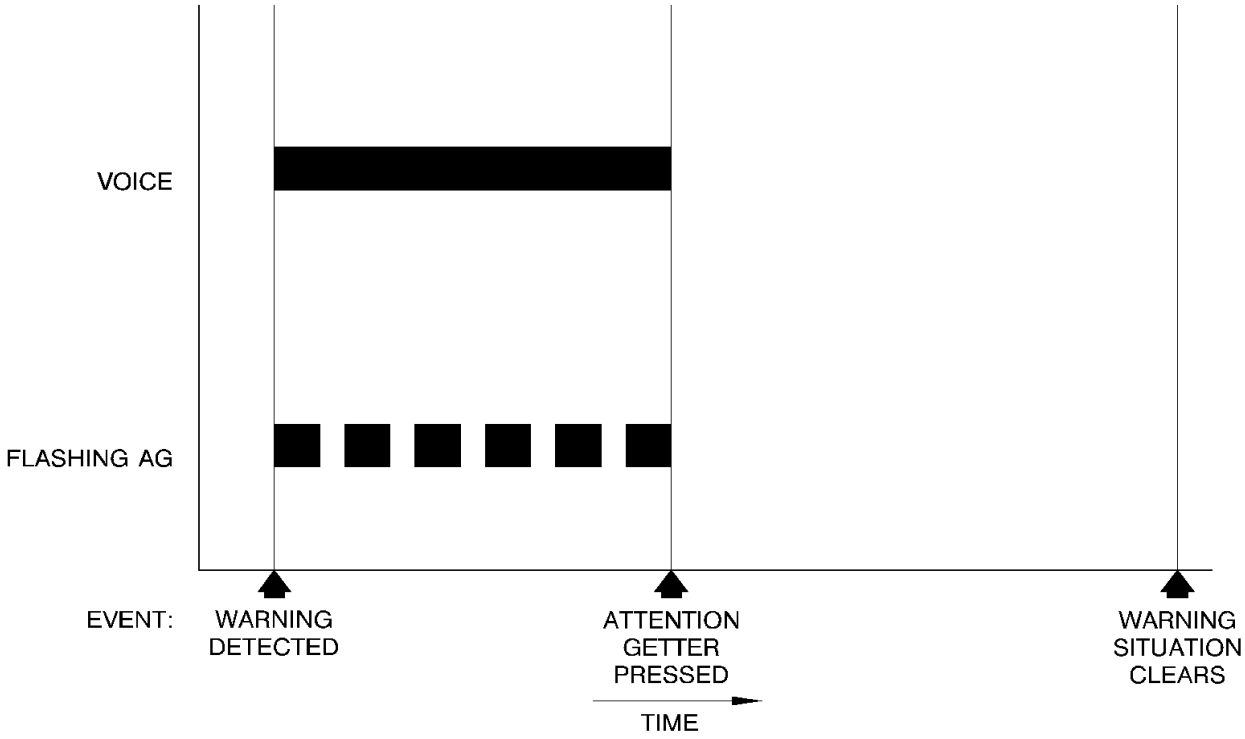


Figure 1.215 - Category 1 Warning Sequence

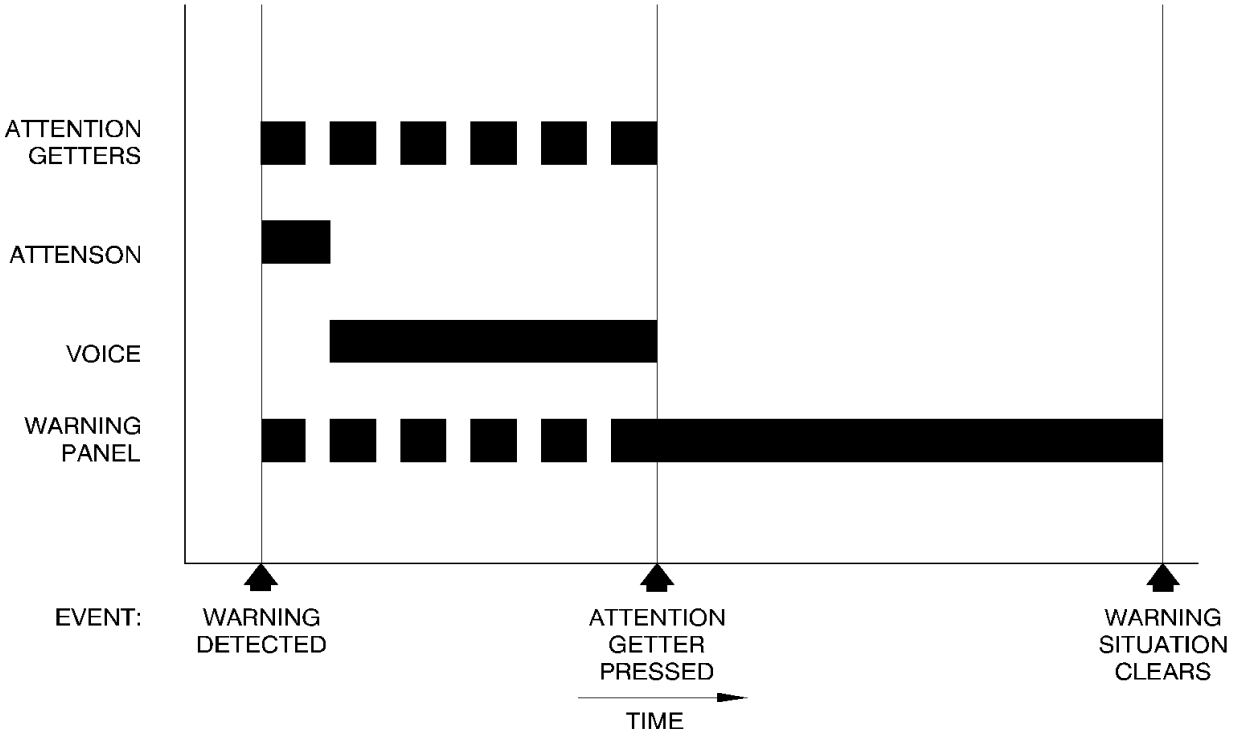


Figure 1.216 - Category 2 Warning Sequence

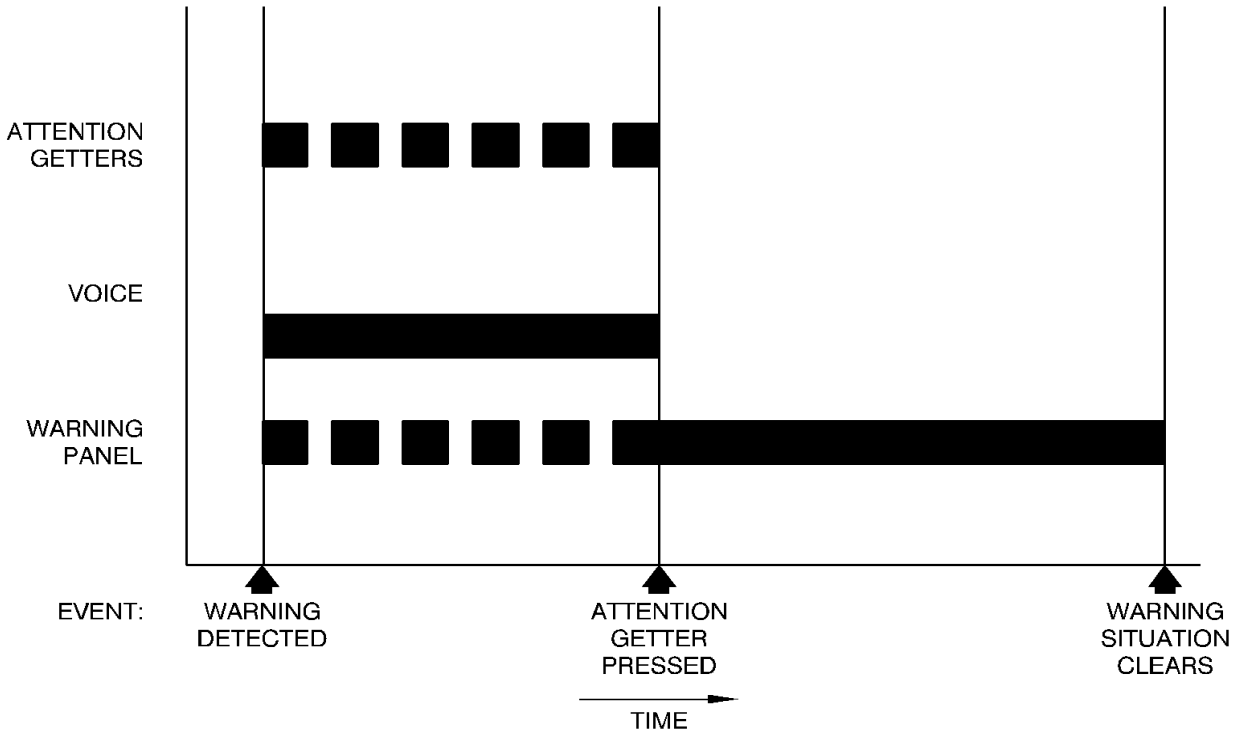


Figure 1.217 - Category 3 Warning Sequence

Dedicated Warning Panel

(1B-B-31-50-30-00A-043A-A Issue 002)

Introduction

The Dedicated Warnings Panel (DWP), Figure 1.218, is situated on the right quarter panel. It consists of a reconfigurable, dot matrix type display capable of presenting 27 captions simultaneously, in three columns of nine. The bottom row of three is reserved for captions related to catastrophic warnings; two are currently defined. Captions are presented either red or amber depending on the classification, category 2 or 3 respectively. A primary warning flashes until acknowledged by the aircrew (pressing one of the attention getters). Secondary warnings are a consequence of primary warnings, and do not flash. When a warning has been acknowledged, the caption remains visible until the warning situation clears.

The captions are presented in the order of priority, from the top to the bottom of the display. Captions associated with systems on the left of the aircraft are displayed on the left of the display; similarly on the right.

The captions are presented such that any red captions always appear at the top of the DWP, with any amber captions beneath them, in their appropriate columns. A subsequent primary warning will appear above any primary warnings of the same category which are already present in a particular column.

A secondary warning will appear above any secondaries of the same category which are already present in a particular column.

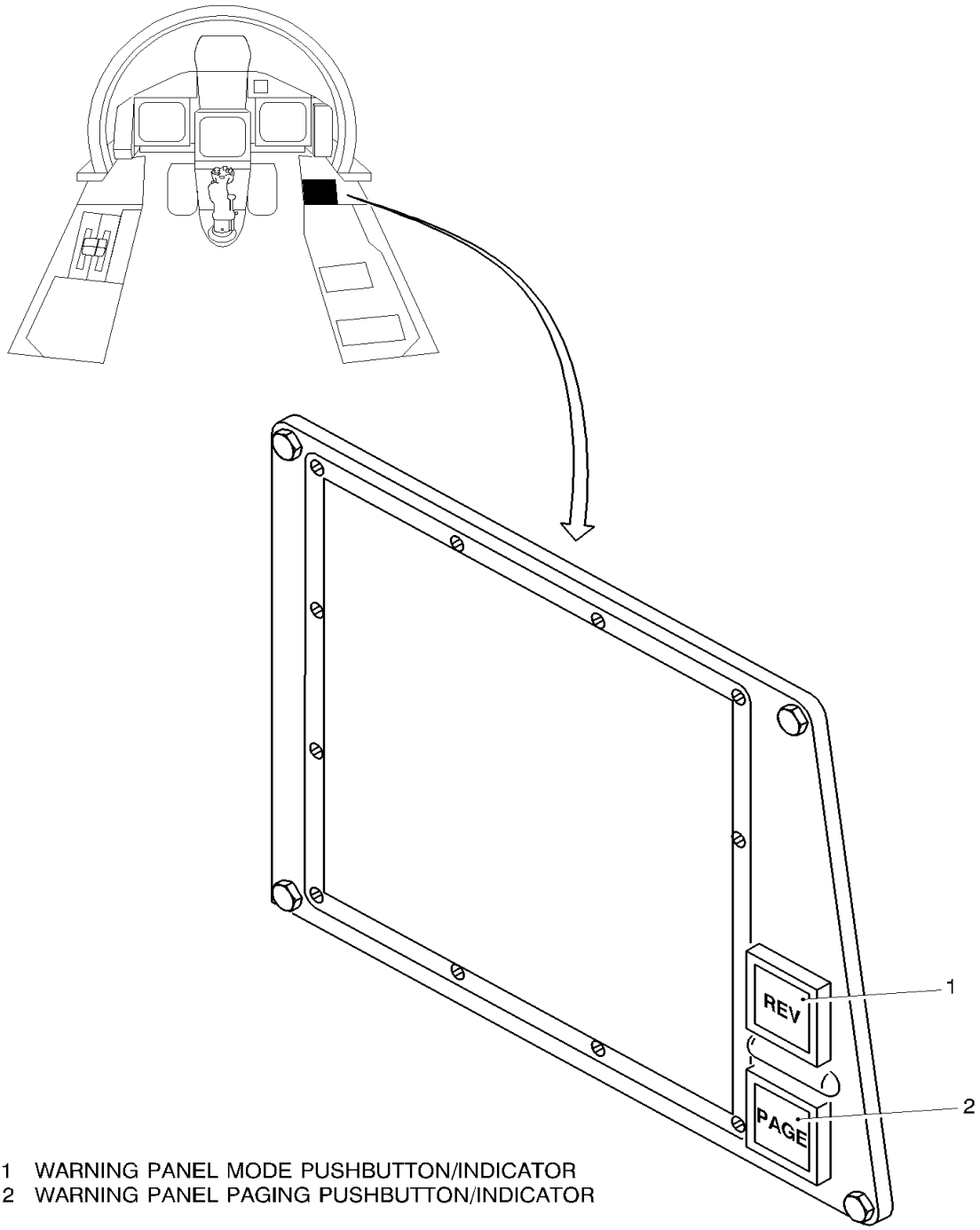
Warning Panel Mode Push Button/ Indicator

The warning panel mode push button/indicator, Figure 1.218, under normal circumstances, is available for selection at all times. This is indicated by illumination of the status bars on the REV push button. Upon selection the DWP enters a reversionary "get-u-home" mode of operation. In addition to manual selection, reversionary mode is engaged automatically when the DWP loses one of its two power supplies, or the avionics data bus fails.

After a manual selection of the reversionary mode, further selection of the push button causes the panel to revert back to the normal mode of operation. Upon successful deselection, the status bars go out. If a detected failure has caused the panel to enter the reversionary mode, selection of the push button has no effect. The normal mode of operation is re-engaged by the system if the fault condition clears.

Warning Panel Paging Push Button/ Indicator

The warning panel paging push button/indicator, Figure 1.218, enables the pilot to scroll through two pages of warnings (if a second is present). If the number of warnings that have been triggered exceed two pages, captions for additional warnings are not displayed. The other elements of these additional warnings will however be provided (attention getters, attensons and voice warnings).
When the first warning panel page becomes full, PAGE is lit on the push button. Upon selection the status bars on the push button are lit. The next page of warnings is displayed upon subsequent selection. Selection again causes the original page to be displayed, and the status bars to go out.



1 WARNING PANEL MODE PUSHBUTTON/INDICATOR
2 WARNING PANEL PAGING PUSHBUTTON/INDICATOR

Figure 1.218 - Dedicated Warning Panel

Audio/Visual Warnings

(1B-B-31-50-40-00A-043A-A Issue 004)

Introduction

The aircraft warning system provides both visual and audio warnings to the pilot. The visual warnings are presented via the attention getters and the Dedicated Warnings Panel (DWP). The audio warnings are presented using attention getting sounds (attenson) and voice warning messages.

Visual Warnings

Two flashing red attention getters, located on the left and right coaming, inform the pilot of a warning situation. By pressing one of the attention getters, the warning is acknowledged and the flashing stops. The DWP presents a visual indication of all category 2 and 3 warnings (including catastrophic warnings). Upon receipt of a warning, the DWP caption will flash until acknowledged, when it will remain steady. A warning which is the result of an indirect system failure will not flash. For further details of the DWP, refer to Dedicated Warning Panel pag. 1-432.

Audio Warnings

Category 1 and 4 warnings generate a voice warning message, but not an attenson. Category 2 warnings carry an attenson and a voice warning message. The voice warning message sounds until the warning is acknowledged. Category 4 warnings are sounded twice and then stop automatically.

Catastrophic Warnings

This category of warning has the highest priority and is indicated by flashing attention getters, a dedicated caption on the DWP and a voice message that plays immediately, interrupting any other audio message. Two catastrophic warnings are defined; a double hydraulics failure and a high integrity warning (Table , “Catastrophic Warning,” on page 1-434).

Catastrophic Warning

CAUSE	VOICE MESSAGE	CAPTION
Double hydraulic system failure	Double hyd fail	HYD TOT
Any one of a small number of FCS related problems which would degrade handling	Reversionary envelope	REV ENV

Reversionary Warnings

In the reversionary mode the DWP shows a limited number of warnings. The captions are in the same positions on the DWP each time they are shown. When a reversionary warning is shown, the caption box and attention getters flash and a voice message will be given (see Table , “Reversionary Warnings,” on page 1-434).

Reversionary Warnings

CAUSE	VOICE MESSAGE	CAPTION
Left engine fire	Left engine fire	L FIRE
Left control circuit hydraulic pressure	Left control pressure	L CONT P
Essential DC failure	Essential DC	ESS DC
Double AC generator failure	Double AC	AC
Double CIU/ CSG failure	Cockpit display	CPT DISP
Oxygen	Oxygen	OXY
APU fire	APU fire	APU FIRE
Right engine fire	Right engine fire	R FIRE
Right control circuit low hydraulic pressure	Right control pressure	R CONT P

Category 1 Warnings

Category 1 warnings are the next highest priority of warning and are indicated by the attention getters and a voice warning message. The message informs the pilot of the condition or the immediate action to

be taken, and continues until the warning is acknowledged or the warning condition clears. The category 1 voice warning messages are shown in Table , “Category 1 Warnings,” on page 1-435.

Category 1 Warnings

CAUSE	VOICE MESSAGE
MASS not live*†	Mass not live
GPWS pull up/Manual pull-up	Pull up
Gear down limit speed	Gear limit
Landing gear not lowered and: airspeed < 180kts altitude < 300ft throttle levers < 75% max dry	Landing gear
Radar altimeter low height†	Low height
Low speed	Speed low recover
Park brake**	Park brake

* TAKEOFF PHASE OF FLIGHT

† CATEGORY 4 IN CERTAIN PHASES OR COMBINATIONS OF WARNINGS

** TAKEOFF AND APPROACH AND LANDING PHASES ONLY

Category 2 Warnings

Category 2 warnings are the next highest priority and are indicated by an attenson, attention getters, a voice message and a red DWP caption. The voice warning message follows the attenson and informs the pilot of the condition. The voice message continues until the acknowledged by pressing the attention getter. The causes, voice messages and captions are shown in Table , “Air Conditioning System,” on page 1-436 thru Table , “Accessory Gear Boxes and Drive System,” on page 1-438 .

Air Conditioning System

CAUSE	VOICE MESSAGE	CAPTION
No cooling to avionic LRI	ECS fan	FAN
Left uncontrolled hot gas leak	Left ECS leak	L ECS LK
Right uncontrolled hot gas leak	Right ECS leak	R ECS LK

Electrical Power System

CAUSE	VOICE MESSAGE	CAPTION
DC generation failure level 2	Electrical second fail	ELEC 2
Essential DC failure*	Essential DC	ESS DC
Double AC generator failure*	Double AC	AC
* REVERSIONARY MODE WARNINGS		

Flight Control System

CAUSE	VOICE MESSAGE	CAPTION
FCS second failure	FCS second fail	FCS 2
Brakes loss of function*	Brakes	BRK FAIL
Auto-throttle failure*	Auto-throttle fail	A THROT
Left intake cowl failure*	Left intake cowl	L COWL
Right intake cowl failure*	Right intake cowl	R COWL
Slat system freeze*	Slats fail	SLATS
Nose wheel steering failure*	Nose wheel steering	NWS
Airbrake failure*	Airbrake fail	A BRAKE
Autopilot failure*	Autopilot	A/PILOT
* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.		

CAUSE	VOICE MESSAGE	CAPTION
Probe heating second failure*	Probe second fail	PROBE 2
Hazardous CG position*	CG one	CG1
Critical CG impingement*	CG two	CG2
Loss of fuel mass or stores	FCS mass	FCS MASS
System failures which would result in degraded handling	FCS reversionary	FCS REV
Air data failure	Air data	AIR DATA
* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.		

Fuel System

CAUSE	VOICE MESSAGE	CAPTION
Left fuel over-temperature*	Left fuel temp	L FUEL T
Right fuel over-temperature*	Right fuel temp	R FUEL T
Left fuel low pressure	Left fuel pressure	L FUEL P
Right fuel low pressure	Right fuel pressure	R FUEL P

* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Hydraulic System

CAUSE	VOICE MESSAGE	CAPTION
Low pressure in left utilities	Left UTIL	L UTIL P
Low pressure in right utilities	Right UTIL	R UTIL P
Catastrophic warning system failure*	Catastrophic warning system fail	CFW FAIL
Left control circuit low hydraulic pressure	Left control pressure	L CONT P
Right control circuit low hydraulic pressure	Right control pressure	R CONT P

* GROUND PHASE OF FLIGHT ONLY

Landing Gear System

CAUSE	VOICE MESSAGE	CAPTION
Brakes loss of function	Brakes	BRK FAIL
Anti-skid loss of function*	Anti skid	A/SKID
Hook down without command*	Hook down	HOOK DWN

* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Navigation System

CAUSE	VOICE MESSAGE	CAPTION
Navigation disparity monitor trip*	Monitor trip	MON TRIP

* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Oxygen System

CAUSE	VOICE MESSAGE	CAPTION
Oxygen*	Oxygen	OXY

* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Airborne Auxiliary Power

CAUSE	VOICE MESSAGE	CAPTION
APU fire*	APU fire	APU FIRE

* THE CANOPY WARNING HORN SOUNDS INTERMITTENTLY WITH THE APU FIRE WARNING.

Windshield and Canopy

CAUSE	VOICE MESSAGE	CAPTION
Canopy not locked	Canopy not locked	CANOPY
Ladder not stowed and locked	Ladder not stowed	LADDER

EJ200 Engine Turbofan

CAUSE	VOICE MESSAGE	CAPTION
Left engine oil low pressure	Left oil pressure	L OIL P
Right engine oil low pressure	Right oil pressure	R OIL P
Left engine fire	Left engine fire	L FIRE
Right engine fire	Right engine fire	R FIRE

* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

CAUSE	VOICE MESSAGE	CAPTION
Left engine performance	Left engine performance	L ENG P
Right engine performance	Right engine performance	R ENG P
Left reheat failure*	Left reheat	L RHEAT
Right reheat failure*	Right reheat	R RHEAT
Left engine flameout	Left engine flameout	L FLAME
Right engine flameout	Right engine flameout	R FLAME
* CATEGORY 3 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.		

Accessory Gear Boxes and Drive System

CAUSE	VOICE MESSAGE	CAPTION
air leak	SPS leak	SPS LEAK
Left gearbox failure	Left gearbox	L GBOX
Right gearbox failure	Right gearbox	R GBOX
Left gearbox lubrication over-temperature	Left gearbox temp	L GBOX T
Right gearbox lubrication over-temperature	Right gearbox temp	R GBOX T
Left air turbine starter motor over speed	Left air turbine	L ATSM
Right air turbine starter motor over speed	Right air turbine	R ATSM

Category 3 Warnings

Category 3 warnings are the next highest priority of warning. The warning starts with attention getters, a voice message and an amber caption. The voice message continues until an attention getter is pushed. The causes, voice messages and captions are given in Table , “Air Conditioning System,” on page 1-439 thru Table , “Tactical Electronic Warfare,” on page 1-442 .

Air Conditioning System

CAUSE	VOICE MESSAGE	CAPTION
Environmental control system failure	ECS	ECS
Cabin low pressure	Cabin low pressure	CABIN LP
Cabin high pressure	Cabin high pressure	CABIN HP

Communication System

CAUSE	VOICE MESSAGE	CAPTION
Communications failure	Comms	COMMS
Voice message failure	(none)	VOICE

Electrical Power System

CAUSE	VOICE MESSAGE	CAPTION
Right AC generator failure	Right generator	R GEN
Left AC generator failure	Left generator	L GEN
Right AC generator over temperature	Right generator temp	R GEN T
Left AC generator over temperature	Left generator temp	L GEN T
DC generation failure level 1	Electrical first fail	ELEC 1
Battery overheat	Battery overheat	BATT T

Flight Control System

CAUSE	VOICE MESSAGE	CAPTION
FCS first failure	FCS first fail	FCS 1
Left intake cowl failure*	Left intake cowl	L COWL
Right intake cowl failure*	Right intake cowl	R COWL
Slat system freeze*	Slats fail	SLATS
Nose wheel steering failure*	Nose wheel steering	NWS
Airbrake failure	Airbrake fail	A BRAKE
Autopilot failure*	Autopilot	A PILOT
Probe heating second failure*	Probe second fail	PROBE 2
Pitch/roll/yaw trim failure	Trim	TRIM
Barometric pressure setting failure	Baro pressure	BARO-SET
Hazardous C.G. position*	CG one	CG1
Critical CG impingement*	CG two	CG2
FCS reset	FCS reset	FCS RSET
Throttle follow-up failure	Follow-up throttle	THROT LK

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Fuel System

CAUSE	VOICE MESSAGE	CAPTION
Left fuel computer failure	Left fuel computer	L FUEL C
Right fuel computer failure	Right fuel computer	R FUEL C
Left fuel over-temperature*	Left fuel temp	L FUEL T
Right fuel over-temperature*	Right fuel temp	R FUEL T
Vent pressure/ temperature	Fuel vent	VENT
Fuel low level	Fuel low	FUEL LOW
IFR probe lock failed	IFR probe	IFR
Fuel transfer	Fuel transfer	XFER
Flight refuel system failure	Fuel valve	FUEL VLV

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Hydraulic System

CAUSE	VOICE MESSAGE	CAPTION
UCS computer failure	UCS computer	UCS CPTR
Air in left hydraulics	Left HYD air	L HYD A
Air in right hydraulics	Right HYD air	R HYD A
Left hydraulics over temperature	Left HYD temp	L HYD T
Right hydraulics over temperature	Right HYD temp	R HYD T

Ice and Rain Protection

CAUSE	VOICE MESSAGE	CAPTION
Ice detected	Icing	ICE
Windscreen heating system failure	Windscreen heater fail	WINDSCRN

Indicating, Recording System, Computing

CAUSE	VOICE MESSAGE	CAPTION
Double CIU failure rear cockpit (T/S A/C only)	Rear CIU	REAR CIU
Map not available	Map	MAP
GPWS failure	GPWS	GPWS
Terrain data unavailable	Terrain data	TERRAIN
Obstacle data unavailable	Obstacle data	OBSTACLE
Double CIU/ CSG failure*	Cockpit display	CPT DISP
CIU single failure	CIU fail	CIU
CSG single failure	CSG fail	CSG
Barometric pressure setting failure	Baro set	BARO-SET

* REVERSIONARY MODE WARNINGS

Landing Gear System

CAUSE	VOICE MESSAGE	CAPTION
Hook down without command*	Hook down	HOOK DWN
Hook loss of function	Hook fail	HOOK
Parachute loss of function	Chute fail	CHUTE
Brakes loss of function*	Brakes	BRK FAIL
Anti-skid loss of function*	Anti skid	A/SKID

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Navigation System

CAUSE	VOICE MESSAGE	CAPTION
Global positioning system failure	GPS	GPS
Laser inertial navigator failure	LINS	LINS
Radar altimeter failure	RAD ALT	RAD ALT
Navigation computer failure	NAV computer	NAV CPTR
Tactical air navigation failure	TACAN	TACAN
Navigation disparity monitor trip*	Monitor trip	MON TRIP

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Oxygen System

CAUSE	VOICE MESSAGE	CAPTION
Oxygen*	Oxygen	OXY
MSOC not in use	MSOC off	MSOC

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

EJ200 Engine Turbofan

CAUSE	VOICE MESSAGE	CAPTION
Left engine oil over-temperature	Left oil temp	L OIL T
Right engine oil over-temperature	Right oil temp	R OIL T
Left engine vibration	Left engine vibration	L VIBR
Right engine vibration	Right engine vibration	R VIBR
Left DECU failure	Left DECU	L DECU
Right DECU failure	Right DECU	R DECU

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

CAUSE	VOICE MESSAGE	CAPTION
Left reheat*	Left reheat	L RHEAT
Right reheat*	Right reheat	R RHEAT

* CATEGORY 2 IN CERTAIN PHASES OF FLIGHT OR COMBINATIONS OF WARNINGS.

Accessory Gear Boxes and Drive System

CAUSE	VOICE MESSAGE	CAPTION
SPS pipe over pressure	SPS over pressure	SPS P
Left SPS computer failure	Left SPS computer	L SPS C
Right SPS computer failure	Right SPS computer	R SPS C
APU door has failed to open	APU door	APU DOOR
Left power take-off shaft failure	Left power off take	L POT
Right power take-off shaft failure	Right power off take	R POT

Surveillance/Attack and Identification

CAUSE	VOICE MESSAGE	CAPTION
Radar shutdown failure	Radar shutdown	RADAR SD
Radar total failure	Radar	RADAR
IFF interrogator failure	Interrogator	IFF INT
IFF interrogator/ tramsmitter cryptovariable failure	IFF crypto	IFF CRYP
IFF interrogator overtemperature	Interrogator temp	INT T
Attack computer failure	Attack computer	ATK CPTR
Transponder failure	Transponder	XPDR

Weapon System

CAUSE	VOICE MESSAGE	CAPTION
NSCAC failure	NSCAC fail	NSCAC
Weapon hang-up	Hang up	HANG-UP
Gun failure	Gun fail	GUN FAIL
Distribution unit failure	DU fail	DU FAIL
ACS failure	ACS fail	ACS FAIL
Selective jettison failure	Selective jettison fail	SJ FAIL
Emergency jettison failure	Emergency jettison fail	EJ FAIL
Gun scoop failure	Gun scoop	GN SCOOP
SCAC channel failure	SCAC	SCAC

Tactical Electronic Warfare

CAUSE	VOICE MESSAGE	CAPTION
Defensive aids computer failure	DASS computer	DAS CPTR
Flare dispenser disabled	Flare dispenser	FLARE
Chaff dispenser failed	Chaff dispenser	CHAFF

Category 4 Warnings

Category 4 warnings have the lowest priority and have a voice message only. The message provides the nature of the warning and is played twice. Table , “Category 4 Warnings,” on page 1-443 gives a list of the causes and the voice messages.

Category 4 Warnings

CAUSE	VOICE MESSAGE	CAPTION
Radar altimeter low height*	Low height	
Throttle override	Auto-throttle	None
Auto-pilot override/ auto-pilot out of limits	Auto-pilot	None
Auto-recover selected	Auto-recover	None
Auto-pull-up	Auto-pull-up	None
FCS override	FCS override	None
Passing 5000ft check height	Five thousand feet	None
Disengagement of baro alt auto-pilot mode	Altitude mode drop-out	None
Supersonic advance warning	Transonic	None
Bingo 1	Bingo 1	None
Bingo 2	Bingo 2	None
Bingo 3	Bingo 3	None
Bingo 4	Bingo 4	None
Autocue failure	Autocue	None
DWP failure	DWP fail	None
Rear DWP failure	Rear DWP fail	None
VVR failure	VVR fail	None
VVR run time check	Check VVR	None
VVR tape end	VVR tape end	None
Terrain valid for GPWS	Terrain valid	None
Obstacle is valid for GPWS	Obstacle valid	None
Mode 4 incorrect own response	Mode 4 response	None
IFF transponder ACC available	Transponder ACC available	None
IFF interrogator ACC available	Interrogator ACC available	None
Simultaneous clear/secure transmit	(beep tone)	None
Gear travel speed	Gear travel	None
MASS not live**	Mass not live	None
Airframe temperature	Airframe temp	None
Maximum speed exceeded	Max speed	None
Auto-throttle reheat required	Select reheat	None
Chaff empty	Chaff empty	None
Flares empty	Flares empty	None
Wing tanks empty	Wing tanks empty	None
Center line tank empty	Center tank empty	None
Hail radio 1	Hail radio 1	None
Hail radio 2	Hail radio 2	None
Radios common tuning	Frequency	None

* In approach and landing phase of flight

** Category 1 in takeoff phase of flight

Fire Warning System

(1B-B-31-50-50-00A-043A-A Issue 005)

Introduction

Engine bay fires are detected by firewire detectors located in each engine bay. When a fire is detected a category 2 warning is initiated, with the associated flashing attention getters. A Dedicated Warnings Panel (DWP) caption is displayed, and an attenson and voice warning message are played.

General

Warning of an engine bay fire/overheat, is indicated on two push button indicators located on either side of the HUD Control Panel (HUDCP), one for the left engine and one for the right engine. Each push button indicator is protected by a cover guard to prevent inadvertent operation of the fire bottle which could damage the engine.

If a fire is detected the caption F, on the respective push button, flashes. By lifting the cover guard and

pressing this push button, the contents of the fire bottle, situated in the engine bay, are discharged. Once the push button has been pressed, further operation will have no effect.
In addition to the flashing of the caption F on the push button indicator, an engine fire is indicated by flashing attention getters, a DWP caption and a voice warning message. The Multifunction Head Down Display (MHDD) engine format will also display either L FIRE, R FIRE or both captions if a double engine fire is detected.
Warning of an APU fire/overheat, category 2, is indicated by flashing attention getters, a DWP caption (APU FIRE) and a voice warning message.
For additional information on DWP captions and voice warning messages, refer to Audio/Visual Warnings pag. 1-434.

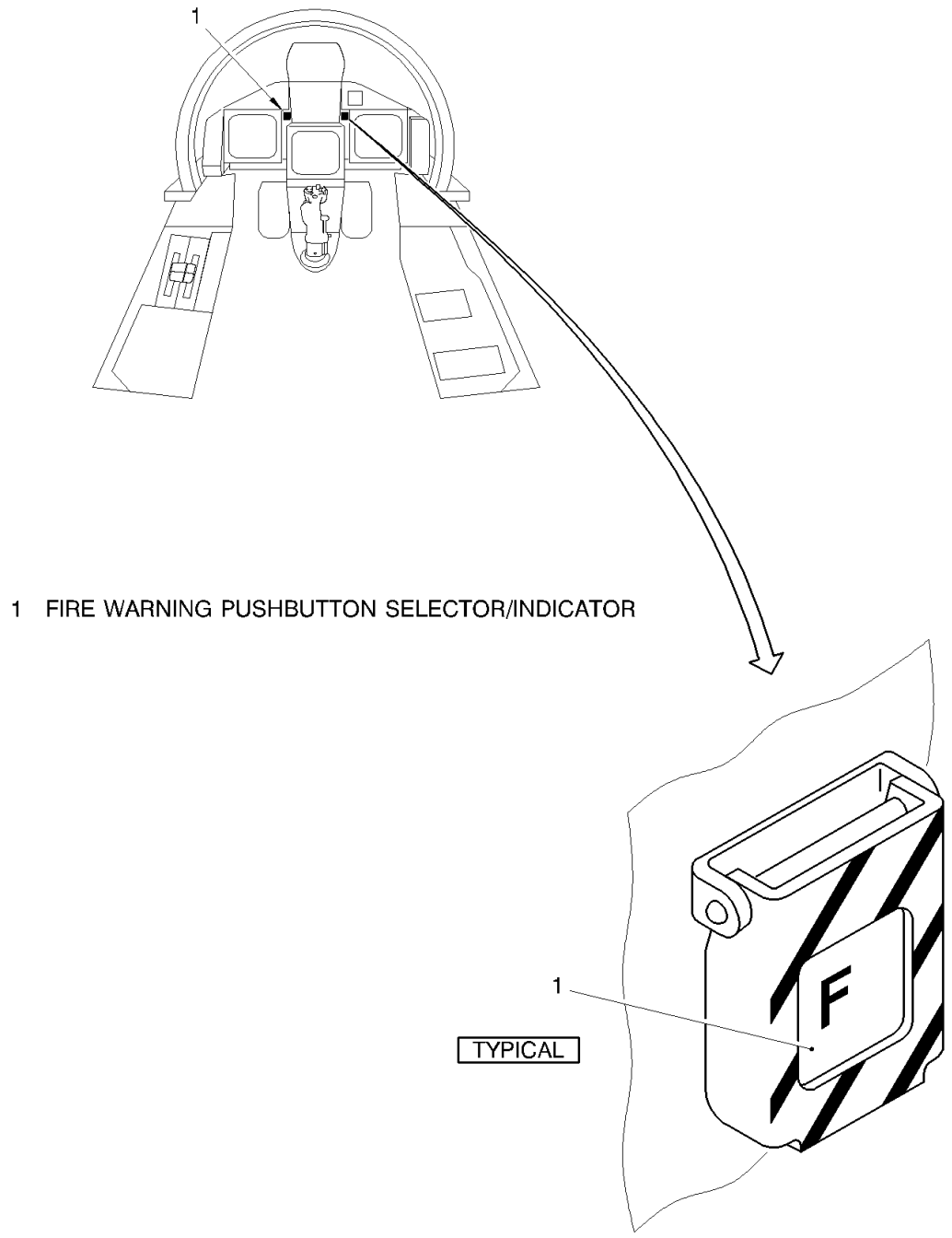


Figure 1.219 - Fire Warning Push Button Indicators

Get-U-Home Warnings

(1B-B-31-50-60-00A-043A-A Issue 004)

General

In the event of a failure of the displays and/or warning systems associated data bus, or a loss of one of its two power supplies, the Dedicated Warnings Panel (DWP) enters a reversionary GUH mode. This mode is also selected when a fault is detected within; the DWP, the link between the DWP and Computer Symbol Generator (CSG), or if data from the CSG is in error. The reversionary mode can also be selected manually via the REV push button indicator next to the DWP. For further details of DWP operation, refer to Dedicated Warning Panel pag. 1-432.

The single page of GUH warnings displays eight category 2 warnings, in fixed positions, driven by dedicated inputs. One category 3 GUH warning may also be displayed. It is generated internally by the DWP when it detects loss of valid data bus inputs. The GUH warnings (Figure 1.220) are listed, with captions, as follows:

– Left engine fire (L FIRE)
– Essential DC failure (ESS DC)
– Right engine fire (R FIRE)
– Double AC failure (AC)
– Low hydraulic pressure in left control circuit (L CONT P)
– Loss of oxygen system (OXY)
– Low hydraulic pressure in right control circuit (R CONT P)
– APU fire (APU FIRE)
– Double CSG/CIU failure (CPT DISP).

In addition, the DWP also displays any catastrophic warnings. These warnings are hardwired and, therefore, can also be displayed in the event of a total loss of power to the DWP. All GUH warnings and the associated audio messages are identical to those in normal operation.

For information on GUH warning management, catastrophic warnings, DWP captions and voice warning messages, refer to Warnings Management and Failure Analysis pag. 1-427 and Audio/Visual Warnings pag. 1-434.

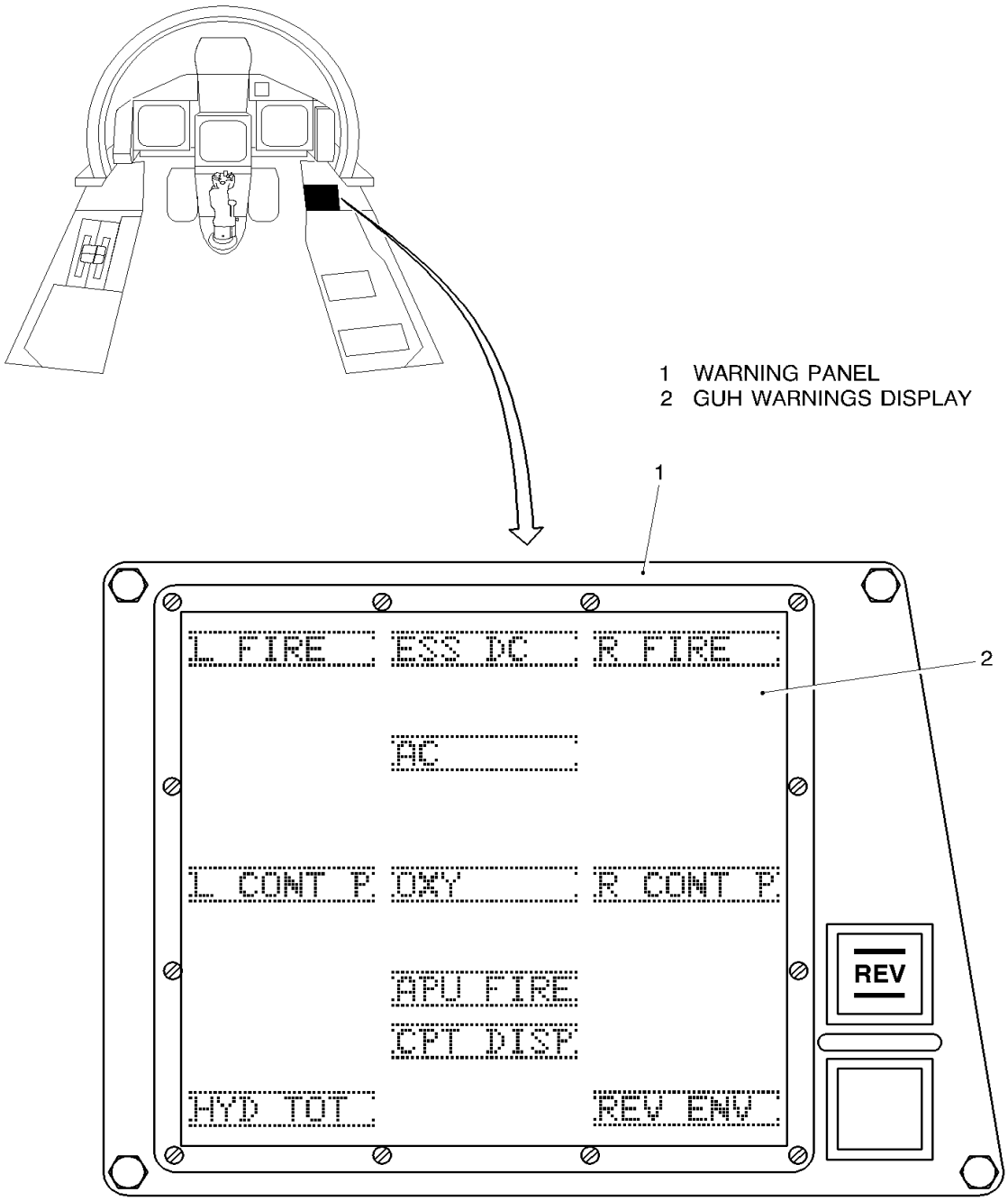


Figure 1.220 - GUH Warnings Display

RECORDERS

Integrated Monitoring and Recording System

(1B-B-31-30-00-00A-043A-A Issue 004)

Introduction

The Integrated Monitoring Test and Recording System (IMRS) collates and processes:

- Aircraft systems status
- Exceedence data of aircraft flight parameters
- Structural data
- Engine health monitoring data.

The data recorded is used to:

- Maximize operational readiness
- Minimize maintenance costs
- Support aircrew debrief
- Assist in accident and incident investigations.

The IMRS consists of the following LRI:

- Interface Processing Unit (IPU)
- Crash Survivable Memory Unit (CSMU)
- Signal Conditioning Unit (SCU) and Sensor
- Bulk Storage Device (BSD), not fitted to all aircraft.
- Video/Voice Recorder (VVR)
- Mission Data Loader Recorder (MDLR)

Failure Reporting

The status of the aircraft is displayed on the MDP as a GO or NOGO indication. If at least one failure is detected, the NOGO caption is displayed.

Built in Test

The various sub-systems of the IMRS have Built-in-Test (BIT) features. These BIT are performed on system power up and constantly monitored during system operation.

Configuration Checking

The aircraft weapons/stores configuration can be input manually via the MDP touch panel or uploaded via the PMDS/MDP.

Structural Health Monitoring

Structural Health Monitoring (SHM) is an on-aircraft software based fatigue monitoring system. Two SHM variants have been developed, these are Parametric and Strain Gauge based.

The Parametric fatigue monitoring method is known as the Baseline system. The Baseline system captures real-time data from the FCS, ACS and the FUG databuses at 16 samples per second. This data is then fed into the on-aircraft stress functions located in the IPU, which calculate the stress and hence the fatigue damage at 10 monitored locations.

Both SHM variants also have the ability to calculate g and auxiliary data and calculate in real-time, exceedences from predefined structural event envelopes.

Data Upload/Download from the MDP

The MDP can be used to upload or download aircraft related data comprising:

- Configuration data
- Initial data for SHM, EHM and SPS life monitoring
- Harmonisation data
- BSD recording definition

Interface Processor Unit

The IPU is the central unit of the IMRS. It performs the interfacing, data acquisition, data compression and data buffering functions for the system. Information is collected from the Avionics, Utilities Control System (UCS) and Attack data buses (ACS), Flight Control Computers (FCC) 3 and 4, the Engine Monitoring Unit (EMU), the Communications Audio Management Unit (CAMU), Signal Conditioning Unit (SCU) and Sensor. The IPU then transmits the data collected to the relevant IMRS storage unit. The IPU also outputs fault data to the Maintenance Data Panel (MDP), part of the UCS, for post flight diagnosis.

Crash Survivable Memory Unit

The CSMU (refer to Crash Survivable Memory Unit pag. 1-453) receives data from the IPU. The data stored is used for accident and incident investigations and is stored in non-volatile memory. The CSMU contains a memory unit, a radio beacon and a sonar locator beacon.

To ensure that recorded data is not erased, post incident or accident, the groundcrew must be instructed to open the CSMU ‘write enable’ circuit breaker.

Signal Conditioning Unit and Sensor

The SHM system has four SCU fitted at various points around the aircraft that are linked to a sensor for recording data on the BSD during `special study' purposes.

Bulk Storage Device

The BSD is used for `special studies,' and stores information for off aircraft analysis. The data is stored in compressed and uncompressed format, received from the IPU, in non-volatile memory. Up to 15 Mbytes of data can be stored and when this limit is reached recording ceases in order to prevent data being overwritten. The information transferred to the BSD can be:

– Engine health monitoring data
– Structural health monitoring data
– Secondary Power System (SPS) monitoring data
– Any other data received and used within the IPU.

All aircraft have the capability to have the BSD installed, although it is not installed to all aircraft.

Video/Voice Recorder

The VVR (refer to Video/Voice Recorder pag. 1-451) uses a standard magnetic video tape to record the information displayed on the MHDD, the HUD and the audio to the pilot's headset. It also records pilot initiated event markers and other data for post flight analysis.

Mission Data Loader Recorder

The MDLR (refer to Mission Data Loader/Recorder pag. 1-449) is used to load data from the Portable Data Store (PDS) to the aircraft systems listed below, and to record selected data for post flight analysis.

– Armament control
– Attack and identification
– Communication
– Defensive aids sub-system
– Controls and displays
– Navigation.

Data is recorded in a specific area of the PDS and will not overwrite data to be downloaded to aircraft systems. Data destruct will occur automatically on pilot ejection or when the SECURE DATA ERASE push button on the left console is depressed.

Mission Data Loader/Recorder

(1B-B-31-31-03-00A-043A-A Issue 002)

Introduction

The Mission Data Loader/Recorder (MDLR) provides the interface between the Portable Data Store (PDS) and aircraft systems via the attack data bus. The PDS is used to load/record data to/from the following aircraft systems:

– Armament Control System (ACS)
– Attack and Identification (AI) system
– Communication system
– Controls and displays system
– Defensive Aids Subsystem (DASS)
– Navigation system.

The MDLR is located on the right rear cockpit console (Figure 1.221).

Operation

Power to the MDLR is supplied by the nonessential busbar PP2. If power is lost the system draws its power from the essential busbar PP3 for a maximum of 400ms. If power does not return to PP2 during this time the MDLR enters the inhibit mode.
The MDLR has three normal modes of operation:

– Standby
– Mission data load
– Mission data record.

Standby Mode

Standby mode is entered when power is applied to the system and the PDS is not installed, the PDS cover on the MDLR is open, or after data erasure has been performed.

Mission Data Load

Mission data is automatically loaded to the aircraft avionics systems when the pilot inserts the PDS into the MDLR, the cover is closed, power is applied to the cockpit bus, and the PBIT has successfully been completed.
The bus controller receives a table specifying the amount of data to be loaded and to which systems. When the required data has been loaded the system enters the record mode.

Record Mode

In this mode of operation DASS emitters and radar Non-Cooperative Identification (NCI) data is stored in non-volatile memory within the PDS. The data recorded is stored in a specific area of the PDS and will not overwrite data that has been previously uploaded to the avionics system.

Data Erase

The data contained within the PDS is automatically erased upon aircrew ejection, or when the cover guarded Secure Data Erase Control push button (Figure 1.221) on the left rear console is depressed, assuming the PDS is inserted into the MDLR.

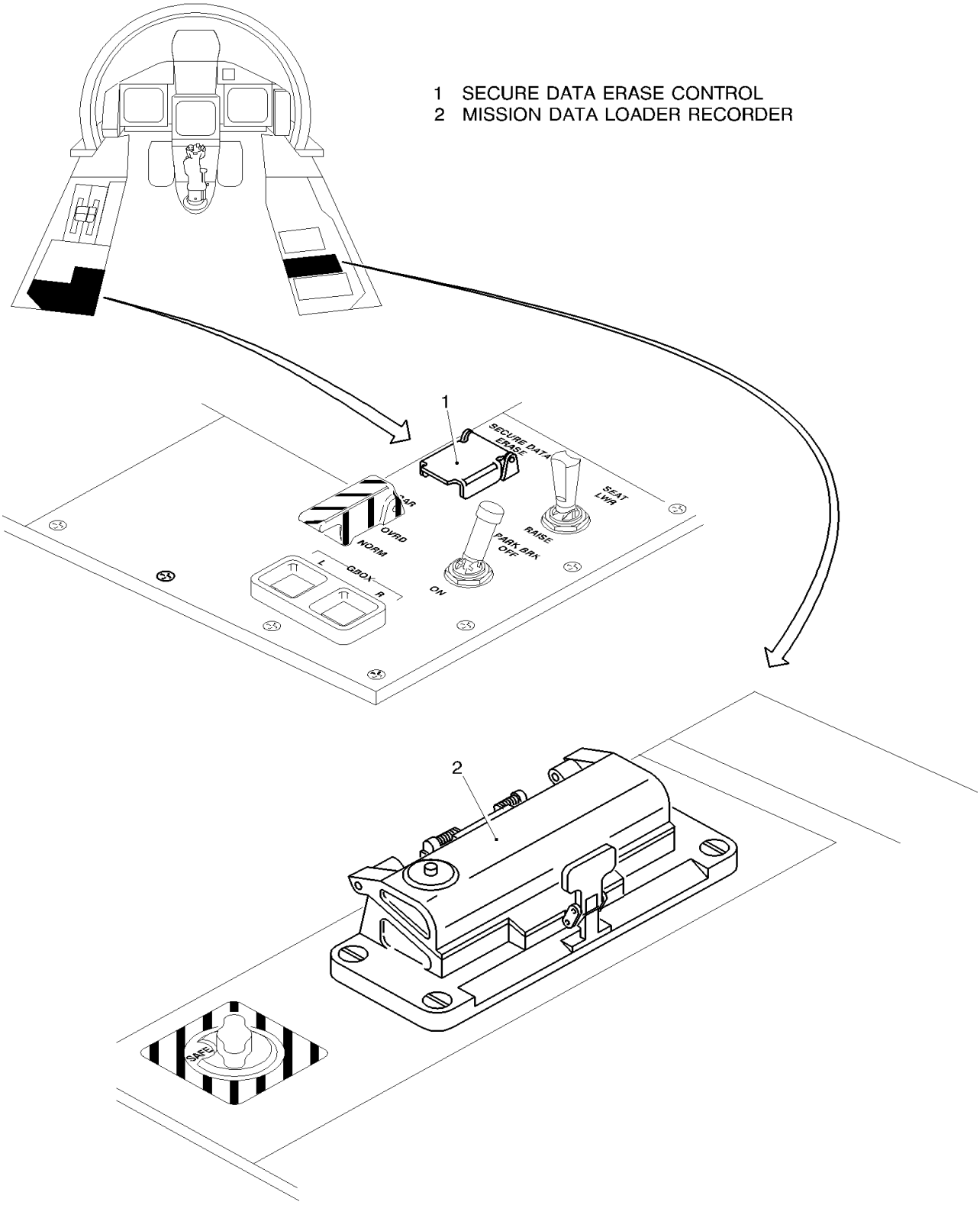


Figure 1.221 - Mission Data Loader Recorder and Secure Data Erase Control

Video/Voice Recorder

(1B-B-31-31-01-00A-043A-A Issue 003)

Introduction

The Video/Voice Recorder (VVR) operates using a Hi8, 8mm magnetic video tape. The VVR has separate video and audio channels and can record video in either color and/or monochrome.

The VVR interfaces with:

- The two Computer Symbol Generators (CSG) (for multiplexed video)
- The Communications Audio Management Unit (CAMU) (for audio)
- The cockpit bus using the Cockpit Interface Unit (CIU). Event marking, time data, navigation data, input selection, mode control signals and status information is received via this interface
- Two discrete signal lines which are used to indicate VVR status - STANDBY and RECORD mode
- One discrete control line to input the manual control signals - STANDBY and RECORD.

The VVR (Figure 1.222) is mounted on the bulkhead on the right side of the front cockpit.

The VVR has an in-built thermostatically controlled heater to dispel moisture and the video cassette access door is also watertight to prevent moisture ingress. If the VVR detects that moisture is present on power-on; the heaters will automatically turn on and operate for a maximum of 16 minutes or until the moisture has evaporated. The PBIT will still operate if moisture is present.

Operation

The VVR automatically enters standby after power-on and completion of PBIT. Once in standby, VVR STBY is displayed on the moding key on the left glareshield (MISC subsystem) and REC (unboxed) is displayed on the VVR push button on the right console.

The pilot can manually select the record mode by pressing the RECORD push button on the right console. The status bars and REC legend then illuminate to indicate that recording has started. The elapsed recording time can be checked at any time by selecting the MDEF/MISC and pressing the SBY/REC moding key. The elasped time is then shown in the MEDF ROL's.

The VVR will also automatically begin to record when weight off wheels and at least one of the following conditions are met:

- A combat PoF (A/A) is selected
- LATE ARM is on
- The radar is in VISIDENT mode and the target range is less than 1NM
- The trigger is depressed to the first detent.

The following events are also recorded to tape when they occur:

- Selection of the first trigger detent
- Release from the first trigger detent
- Selection of the second trigger detent
- Release from the second trigger detent
- Release of weapons.

NOTE

The last event recorded on the VVR will be the weapon release pulses

The VVR automatically reverts back to standby (SBY) after 15 seconds when each of these events is no longer true.

The VVR will either remain in, or enter the OFF mode when:

- No tape cassette present, or it is not correctly inserted
- Moisture is still present after the VVR heater has been on for 16 minutes
- An ‘end of mission’ signal has been received by the VVR
- The end of the tape has been reached.

If the VVR fails PBIT, CBIT or IBIT, VVR FAIL, with status bars, is displayed on the moding key and REC on the right console push button goes out.

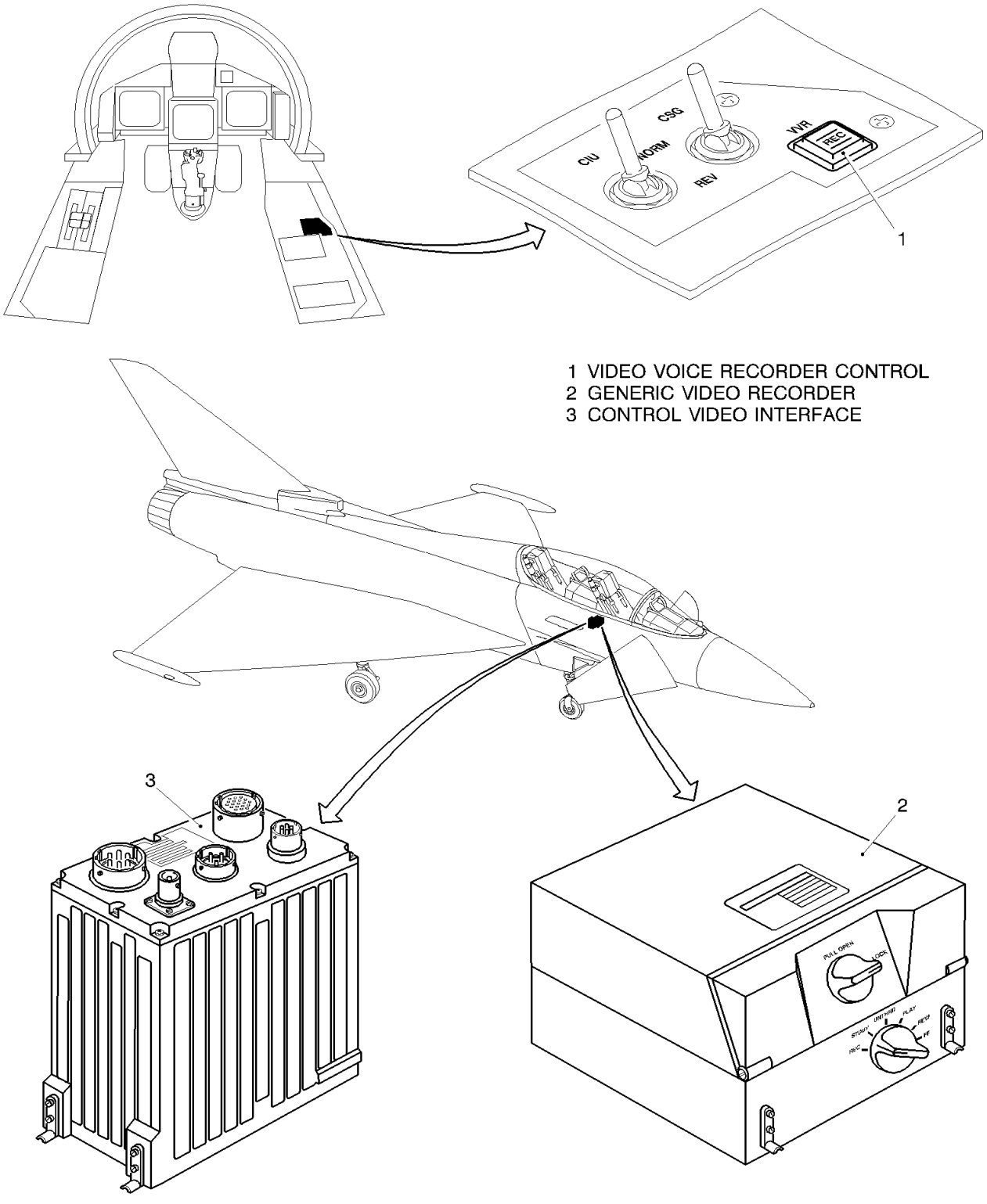


Figure 1.222 - Video/Voice Recorder

Crash Survivable Memory Unit

(1B-B-31-31-05-00A-043A-A Issue 002)

Introduction

The Crash Survivalble Memory Unit (CSMU) is a solid state, 6 Mbyte, non-volatile flight data recorder that has a beacon unit attached to its rear panel. The beacon unit contains a UHF radio locator beacon, underwater(sonar) locator beacon, batteries and an antenna. The CSMU recieves and records data in a crash protected Electrically Erasable Programmable Memory (EEPROM). The CSMU records data from the aircraft data busses, the Communications and Audio Management Unit (CAMU) and the Flight Control System (FCS) to assist in incident and accident investigations. Data is passed to the CSMU via the Interface Processor Unit (IPU).

Recorded Data

The following information is recorded in digital format:

– Engine start data, FCS actuator check data and data 90 seconds before and after WOW
– The last 90 minutes of flight data, stored in compressed format
– The last 30 seconds of flight data, stored uncompressed
– The last 30 minutes of all headset audio.

CSMU Activation

The CSMU is activated when power is applied to the aircraft and the previously stored data is automatically erased. However, if the CSMU ‘write enable’ circuit breaker has been set open after the previous flight, data stored in the CSMU will not be erased when power to the aircraft is re-applied.

Downloading of Recorded Data

Recorded data from the CSMU for post-flight analysis can be downloaded off-aircraft, via the Ground Support System (GSS), or whilst on-aircraft via the Ground Loading Unit (GLU).

Operation

If the aircraft suffers an impact greater than 35.5g in any direction, the UHF radio locator beacon is activated and transmits a signal on 243MHz . This UHF emergency signal has an effective range of 50nm. The sonar locator beacon activates immediately upon immersion in water and transmits a 38kHz signal with an effective range of 1.5nm.

Cryptovariable Management System

(1B-B-31-34-00-00A-043A-A Issue 003)

Introduction

The Aircraft Cryptovariable Management System (ACVMS) provides the storage and management of cryptovariables required for operation of the following equipment:

– V/UHF1
– V/UHF2
– MIDS
– GPS
– IFF Transponder
– IFF Interrogator.

Encrypted key variables are required by the Multifunctional Information and Distribution System (MIDS), V/UHF1 and 2, whilst nonencrypted key variables are used by the GPS, IFF transponder and interrogator.
The system also provides Universal Time Coordinated (UTC) time to the avionics system. This is supplied to the avionic systems by the UTC clock module via the Aircraft Crypto-Variable Management Unit (ACVMU).
The ACVMS is currently an interim fit to facilitate the loading of encrypted and nonencrypted variables. The system will be fully operational after installation of the ACVMU.

Interim Installation

The additional equipment for the interim fit is a dummy LRI, fitted on the management unit mounting tray located in the avionics bay, and an extra `back-up' cable to enable loading of nonencrypted variables (Figure 1.223). The cable is connected between an additional (NONENCRYPTED) fill port in the right wing apex and the mounting tray.
The loading of encrypted key variables to avionics systems is achieved using the BULK FILL connector which is also located in the right wing apex.

Fully Operational Installation

The ACVMU will accept, store and manage both encrypted and nonencrypted key variables loaded via the BULK FILL port in the right wing apex (Figure 1.224). The UTC clock supplies time signals to avionic equipment via the management unit and avionics data bus.
The management unit will distribute, when commanded, encrypted variables to V/UHF1, V/UHF2 and the MIDS. Nonencrypted key variables will be loaded to the GPS, IFF transponder and IFF interrogator.

Cryptovariable data is erased automatically on pilot ejection, or when the pilot presses the SECURE DATA ERASE button located on the left console.

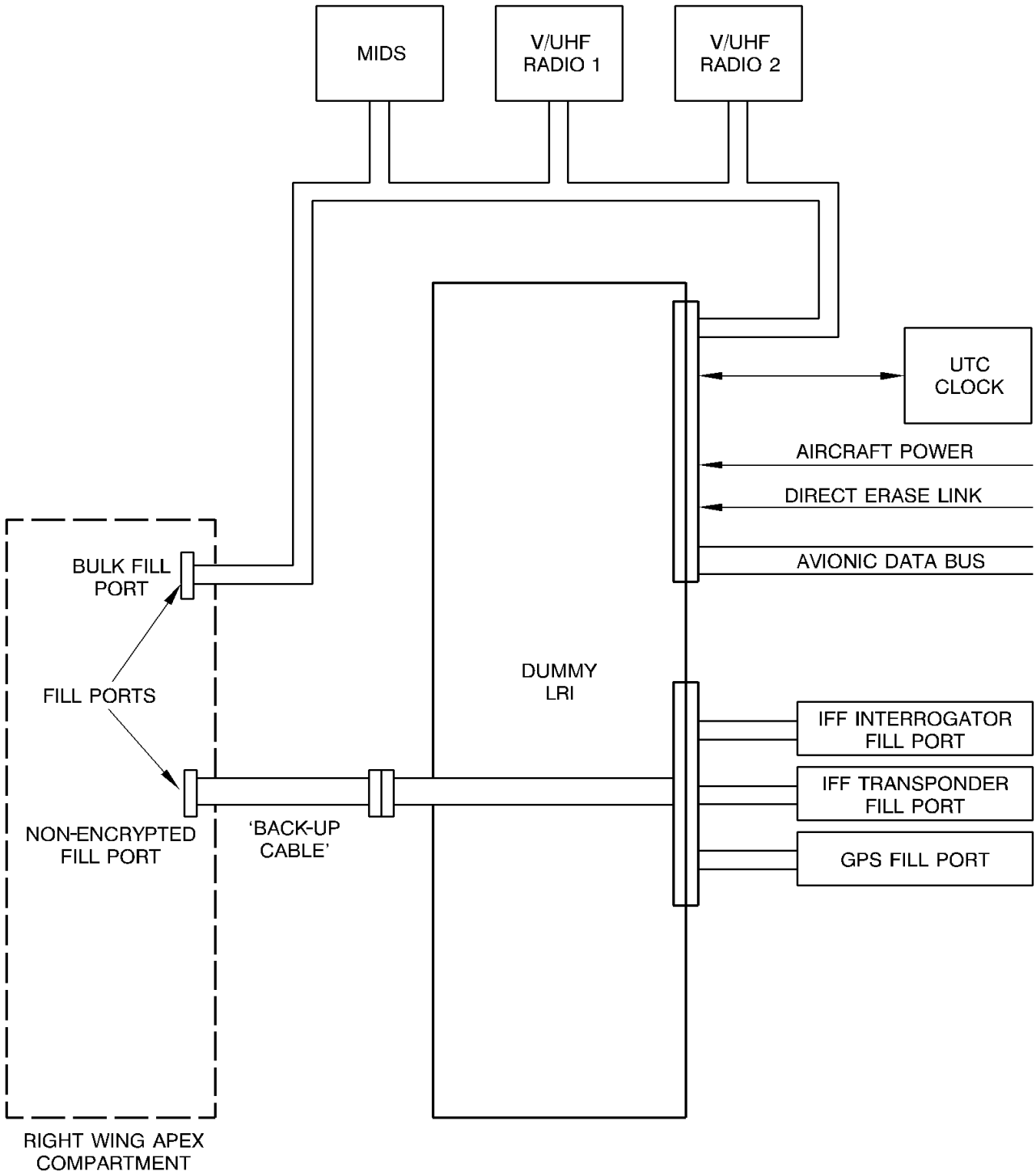


Figure 1.223 - Interim Installation

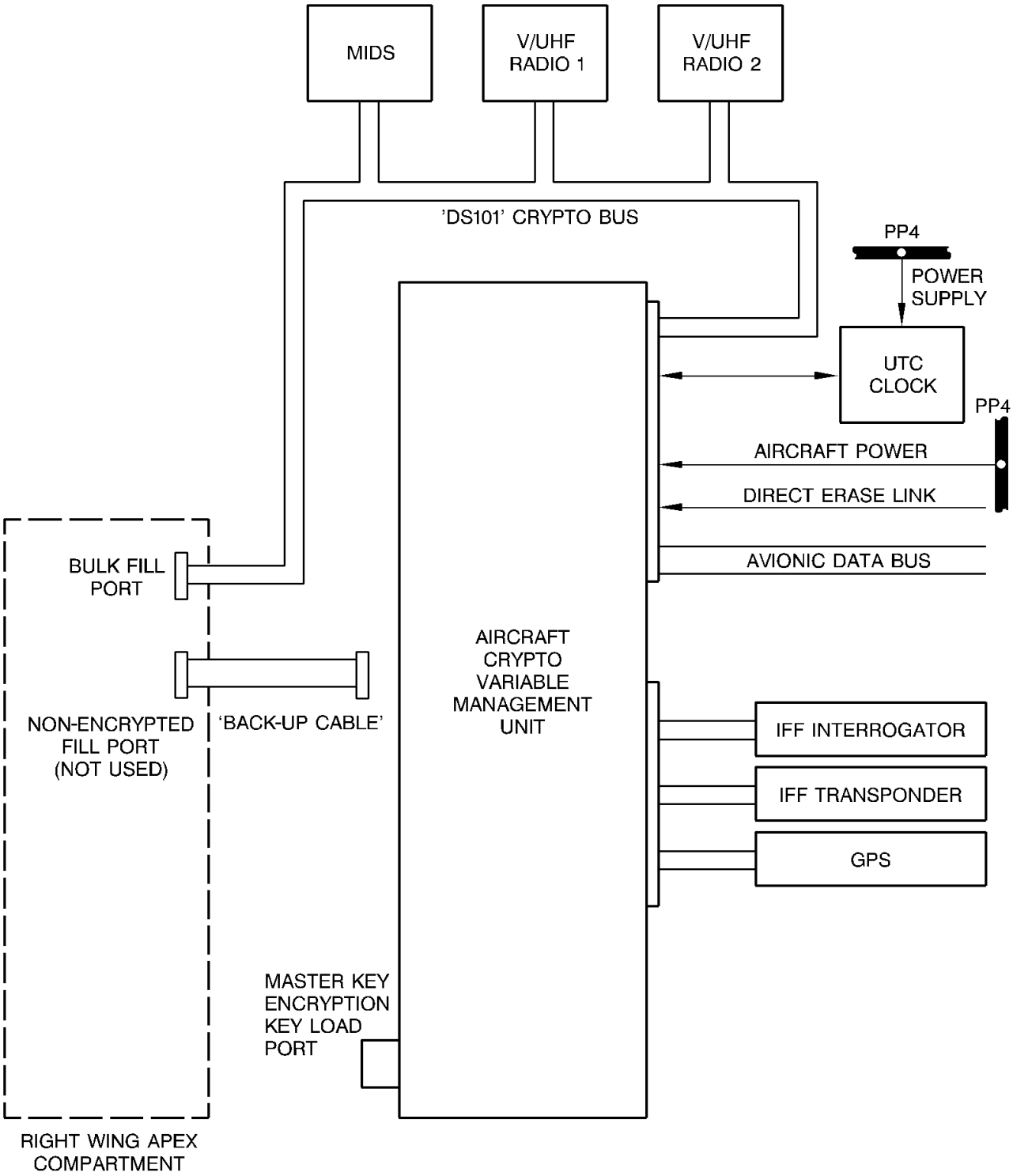


Figure 1.224 - Fully Operational Installation

SUIRVELLANCE/ATTACK AND IDENTIFICATION

Surveillance/Attack and Identification Subsystem

(1B-B-93-00-00-00A-043A-A Issue 006)

General

The Attack and Identification Subsystem enables detection, acquisition, identification, prioritizing and engagement of air, ground and sea targets, during day and night, in all weather conditions.

The Attack and Identification Subsystem consists of the following equipment:

- RADAR
- IFF Interrogator
- IFF Transponder
- Attack Computer

Attack and Identification Subsystem Functions

The Attack and Identification Subsystem includes the following primary functions:

- The control and operation of the Radar to provide Air-to-Air target location.
- The control and operation of the IFF Interrogator to provide identification of radar targets.
- Correlation of radar tracks and IFF information and distribution of fused tracks for display and other users.
- The control and provision of VISident steering and Air-to-Air Missile aiming information.
- The provision of slaving of SRAAM missiles either by radar or the XY Controller.
- The pre-launch and post-launch support of Medium Range Air-to-Air Missile aiming information.
- The provision of Air-to-Air Gun aiming information.
- The control and operation of the Radar to provide an Air-to-Surface ground mapping.
- The control and operation of the IFF Transponder to provide self identification of the aircraft.
- The provision of Ground Static Harmonization for the Radar and Air-to-Air Gun.
- The monitoring and reporting of the Attack and Identification Subsystem status.

Sensor Data (Plots, Tracks, Targets)

Types of sensor data

Sensor data will be presented as plots, tracks or targets.

Plots

Plots are detections of the radar or IFF interrogator which have not been correlated with previous detections. Plots are sent directly to the CSG without attack computer processing and therefore are always unknown.
All plot displays are synthetic; no raw sensor data is displayed in air-to-air modes. A maximum of 180 plots will be displayed.
Plots detected by the radar are initially displayed as 3 x 1.5 mm amber colored rectangles. The plots are displayed for a finite time and decrease in size progressively; the "ageing" time of the plots is usually controlled automatically (AUTO) but can be defined by selecting the "AGE" soft key. Settings of 5, 10 and 15 seconds will be available by toggling through the displayed menu options on the attack format using the plot ageing softkey and leaving the boxed symbol over the desired option for three seconds. The new plot ageing option is displayed on the softkey.
Once the radar correlates the plots (the radar detects the plot at least twice within the first four frames) tracks are formed.

Tracks

Tracks are detections of one or more sensors which have been correlated with previous detections.
In TWS the radar will automatically determine which plots are to be tracked (up to 20 tracks), dependent on relative priorities of sensor detections. As the priority assignment may not consider the tactical situation, plots can be selected manually to be included in the tracking process by XY insert over a plot on the AF or EF. The system will accept up to 20 manually initiated tracks. If 20 tracks have been manually initiated it is not possible to initiate tracking on another track (manually or automatically). Manual track deletion must be used if other tracks are required.
The manually inserted track cannot be overridden automatically by the radar initiated tracks.
A maximum of 20 tracks will be displayed, regardless of automatic or manual initiation. Note if STT is initiated on a plot, not tracked so far, 21 tracks are presented for a short time (dependent of scan volume and track quality for a maximum time of seven frames) until the first 20 tracks, which then have gone into memory, are deleted.
Manual track initiation is not possible when the RAID picture is displayed.
Different track symbology outline indicates which sensors are supporting a track. The pilot may use this information to reschedule the search priorities of a sensor e.g. Radar.
The correlated track symbols will be displayed with velocity vector and the various Extra Information, which contain the accumulated knowledge from all

available sensors and provide the best understanding of track movement and track identity.

Track Group Symbol (TGS)

If a sensor detects several tracks in the same area or sensor data has not yet fused, the resulting tracks symbols could overlay each other on the MHDDs; this would result in serious display clutter and it would be difficult for the pilot to identify the track symbols, their TCRIs, velocity vectors etc. This problem is solved by Track Group Symbols on the Attack and PA formats. When two or more track symbols approach within five mm of each other, they are replaced by a single symbol (TGS), a hexagon. Note that the TGS is purely a display function, and has nothing to do with the sensors' or the correlation processes' ability to discriminate between close tracks. For example, two tracks that can be displayed separately when the Attack format is set on a low range scale will form a TGS as the display range is increased and the tracks become progressively closer on the display. Note that plots will not be included in the TGS.

On the AF, the TGS also displays the velocity vectors of the components tracks. Different vectors are drawn for each angle between tracks that are different by more than 20°, e.g. if all component tracks are within 20° then only one vector is drawn, otherwise a vector is drawn for each one. If velocity vectors of different speeds lie within the same 20° interval, the fastest vector will be shown.

The components of a TGS on the AF are shown by the TCRI in the center of the TGS - this relates to the component track that has the highest position in the designated target list (DTL), or is the highest system priority in the absence of nominated targets - additional components are shown as a string of max. five TCRIs drawn just above the TGS. Friendly, unknown and any hostile tracks (at FOC) not allocated a TCRI, are indicated by a '*'.

The color infill of the TGS represents the allegiance of the highest priority track within the group. On the AF the system priority (1–6) of the TGS top component is shown at the right of the TGS. When extra information is selected or the TGS is within 20 NM in PoF T/O or LDG the altitude of the top component is displayed instead. On the PA format, only the number of tracks within the TGS are shown, as a number above the symbol. A change priority alert for any TGS component is shown on the Attack and PA Formats by flashing the TGS symbol including the TCRI components string. If PTA is performed, this track becomes highest in DTL and flashing will cease.

The outline of the TGS symbol will reflect by which sensor(s) the top component is being tracked.

When the radar locks onto a TGS component a lock on cross will be shown with the TGS, but it will not be possible to lock-on to TGS top component by placing the XY marker over the TGS and pressing the HOTAS lock button.

Launch Success Zones and raid numbers will only be shown to the top component of the TGS.

A missile in flight against the TGS top component will be shown by changing the infill color to blue. The missile in flight flashing and occulting conditions will be as for normal tracks/targets. Missile in flight against any other components of the TGS will not be shown.

If an IFF interrogation is performed over a TGS, a sector interrogation will result.

The pilot can "open" a TGS by placing the XY cursor over the symbol and inserting. This changes the AF to an expanded TGS zoom box of 4, 10 or 20 NM square (dependent on underlying AF range setting). The display box is stabilized on the centroid of the TGS tracks, and presents an expanded picture in which the pilot can see the relative position of the tracks. A "PP" square also positioned on the TGS box shows the position of the TGS on the underlying AF. The display also includes the underlying range scale and the expanded display type and size. The track components in this TGS zoom box may be manipulated exactly as on the normal Attack Format. The box is closed again by XY insert anywhere outside the ROLs (provided no CSI is captured), or selecting a RAID picture, or until any other format is selected.

Expanded display moding on the PA format is different, there being three different types of zoom available, refer also to Table , “A&I XY Functions with Plots/Tracks/Target/TGS,” on page 1-467:

1 TGS Zoom: A short XY insert on a PA TGS symbol causes display of a TGS zoom box, the center stabilized on the centroid of the TGS. The box size is dependent on the PA range scale from which it was selected.

2 Track Zoom: A long XY insert on a track creates a similar expanded zoom box, centered and stabilized on the track.

3 Area Zoom: A long XY insert, not on a track, creates a similar expanded zoom box, centered on the insert point and ground stabilized.

Track Filtering

To avoid overloading the pilot with hundreds of tracks, the Avionics System limits the number of tracks to be displayed to 120. The filtering ensures that priority tracks are always displayed.

Tracks which do not meet the priority criteria are filtered on a range basis until the maximum number for display is reached.

The pilot can adjust the position about which range filtering takes place, based on his display requirements. If the pilot selects the window on the world icon, he is then able to use the XY controller to

adjust the view of the world represented on the PA format. (This display does not need to include own aircraft position). The range filtering is therefore based on own aircraft position or the selected center of the window on the world.

Targets

Tracks can be nominated as targets for attack or VISident by using the XY controller.
The system may hold up to eight targets and Priority Target Accept (PTA) will generate six targets.
Any air to air tracks may be nominated as targets.

Indication of Track/Target Data

Display of Track/Target Data on MHDDs

Tracks are displayed with a bright white outline.
Targets are displayed with a double white outline. To differentiate the number one target track symbol it has a bright white double thickness outline.
For a complete list of the available track/target symbols refer to Surveillance/Attack and Identification pag. 1-471. The attributes indicated by variations in track/target symbol shape, color infill, outline, and peripheral symbols are as follows:

– Allegiance (Track Identity): - Tracks are classified as Friendlies, Unknowns. The allegiance is indicated to the pilot by the shape and color of the symbol.
  - Friendlies are displayed as circles, with a green infill.
  - Unknowns are displayed as a square with an amber infill.

– Pilot Identity Override (PIO) - The pilot may change the displayed classification of a track by XY inserting on the PIO icon, and then XY inserting on that track. The first insert changes the track “shape” to the next classification, depending on the initial classification of the track. A second insert reverts the symbol to its original shape. Note that the infill always remains as decided by the weapons system. For example, a round symbol with an amber infill is an unknown track the pilot has converted to a friendly. The PIO action can be cancelled by XY insert on a blank space, on anything other than a track, insert over the PIO icon or when marker is moved off the format. Any previously converted tracks remain converted on PIO cancel. PIO will have no effect on a TGS but may be performed on the components in the TGS zoom picture. A PIO which has been performed on a TGS top component cannot be seen on the Track Group Symbol, as the shape will stay a hexagon and the infill will always show the system hostility. Note that TGS zoom is not possible while PIO is active, therfore TGS zoom must be performed before enabling PIO.

– Tracks, targets and first target: - Tracks are initially displayed as symbols with a single white outline. If the track is nominated as a target a double white outline is used. To differentiate further the number one target track symbol (i.e. the first target to be engaged and to which the weapon aiming displays apply) has a bright white double thickness outline.

– Track Cross-Reference Indicator (TCRI) - A TCRI is an alphabetical character assigned to unknown tracks and targets on the head-down tactical displays, and on the designated targets on the HUD. The character assigned to a particular track/target is the same on all the displays. The TCRI is used by the pilot to cross-relate track symbols between the various formats and the readout lines on the formats. Note that the simulated target will not have a TCRI assigned.

– Track Velocity Vector (Aspect Angle) - If the system is able to calculate the course and speed of a track, it is indicated by a vector drawn from the track symbol. The angle of the vector against the Attack format grid indicates Angle Between Courses, while the length of the vector is proportional to target speed (TAS). There are three lengths (3, 5 or 7 mm), equivalent to target TAS of 0-300 kts, 300-600 kts, and greater than 600 kts, see Figure Track Attribute Symbology. In the Elevation format the vector indicates also climb or dive greater than 2000 ft/min. In the HUD and HUD HD format the length of the “angle pointer” varies with the size of the TD box and does not indicate target speed.

– Direction of Turn - If the system detects that the track is turning at a rate greater than or equal to five g, the direction of turn is indicated by a short "arm", pointing in the direction of turn, on the end of the velocity vector. Note that high g target maneuvers will not be measured with sufficient accuracy in TWS/PT/PS due to the low track update rate in this modes and are therefore not indicated.

– Rapid Height Change - If a track is detected as climbing or descending at more than 6000 ft/ min, an arrow is drawn pointing up or down from the edge of the track symbol.

– System Track Priority - The system continuously evaluates the threat priority of unknown tracks, and indicates the result of this evaluation for the six highest priority tracks by a single white digit number to the top right of the track symbol. The highest priority is labelled "1". The priority will be occulted while track altitude is displayed (see below).

– Track Altitude - The system calculated track altitude is shown to the top right of the track symbol whenever an initial XY insert on the track symbol is made. It over-writes any threat priority indication (presented at the same position) and is shown as a cyan two-digit number, indicating altitude in thousands of feet (e.g. "15" indicates track altitude is 15,000 ft). The display automatically occults seven seconds after selection; until time out. In PoF T/O and LDG the track altitude will be displayed permanently within 20 NM.

– Relative Altitude Bar - A horizontal bar is displayed if the track is more than 10,000 ft different in altitude to own aircraft. The bar is on the top of the track symbol if the track is below, on the bottom of the symbol if the track is above.

– Memorized Track/Target If a target or track leaves the Radar Scan Coverage it will be memorized by the radar and displayed with a dashed symbol outline and if a missile is in flight the dashed outline will be with blue infill. If a lock Follow mode was entered from TWS mode (except via an Air Combat Mode - ACM) then the existing TWS tracks will also “go into memory, because the radar then will only be tracking a single object. If the radar stays in the Lock Follow mode for a period of time the memorized tracks will be automatically deleted. On selection of an ACM all existing track files are deleted immediately.

Display of Track/Target Data on HUD

Targets are displayed on the HUD in three different sizes of Target Designation (TD) boxes to give an indication of track range. The largest TD box indicates range less than 10 NM, medium indicates between 10 and 20 NM, and the smallest indicates range greater than 20 NM. The TCRI for Unknowns will appear above the symbol. A maximum of eight TD boxes can be displayed on the HUD at any one time.

The TD box for the number one DTL target is displayed on the HUD at all times; when the target moves out of HUD-FoV the TD moves along the HUD boarder and blinks.

TD boxes, which have a medium range missile in flight against them are marked by a cross and will disappear outside HUD-FoV.

A range countdown circle indicates that the number one target is less than 12 000 feet.

Memorized objects are displayed as follows, because no color is available on HUD:

HUD Target Designation Symbology

OBJECT	RADAR TRACKED	RADAR MEMORIZED
Track	dashed, 4 dashes	dashed, 8 dashes
Target	single line	dashed, 8 dashes
Number one target	double line	dashed double line, 8 dashes

Simulated Target

For training purpose the Attack Computer can generate a synthetic track, selectable on the MDEF via the MISC SSK and SIM TGT MK, refer to Figure 1.226. The synthetic track is shown on all cockpit displays as a memorized unknown track which does not stale out and occult with time as the real ones. It can be managed like a real track (e.g. target nomination, simulated missile firing) and will cause real displays and responses from the weapon system like missile steering cues, missile priming, post-launch support. It will be presented with the following default values:

– Azimuth: 20° left of own heading
– Altitude: 10 000 ft below own aircraft height (minimum 5000 ft above MSL)
– Slant range: 50 NM
– Groundspeed: 400 Kts
– Groundtrack: straight and level opposite of own heading.

To start again with default values, the SIM TGT function must be de- and reselected on the MDEF. It is not possible to initiate radar lock against the simulated track, nor to delete the track (i.e. using the bin function). The track is deleted by deselecting the SIM TGT MDEF soft key.

Upon selection the target will fly straight and level with a groundspeed of 400 kts opposite of own heading at selection. The target will continue to fly on this heading independant of own maneuvers.

The function remains operational if the MISC SS is deselected.

For numerical reasons the synthetic target is only initiated if own latitude is within -70 to +70 deg.

The synthetic target is not included in the target priorization process and has no TCRI assigned.

The simulated target will be deselected automatically after 10 minutes.

Extra Track/Target Information

Extra information on tracks/targets are shown in two Read Out Lines (ROL) on the bottom of the Attack

format either on default or by selecting with XY controller.
The left ROL displays number one target information only and will be blank if no number one target is available.
The right ROL shows information of second priority or XY controller selected targets/tracks.
If there are no tracks selected for extra data then extra information for the highest priority track will be displayed in the AF right ROL.
If XY insert is pressed when the cursor is over a track, a two-digit readout of the height of all targets and tracks within AF coverage is displayed at the top right of each track symbol; these occult automatically after seven seconds, or immediately if the XY is moved off the track.
Target extra data is indicated using the XY controller by positioning over the target reference in the DTL. As the XY marker passes each of the target references in the DTL the extra information for that target is displayed in the AF right ROL and the EF ROL.
The following information is available:

- Track Cross-Reference Indicator, if determined by the avionics system; friendlies do not have a TCRI and therefore a green circle is displayed
- the approximate track size, SMALL, MEDIUM, LARGE, or N/A if not available, based on Radar cross-section; for the synthetic target SIM will be displayed
- the approximate TAS (KT) or MACH (M), depending on status of own aircraft speed on the AF
- the approximate ground track of the track in degrees with three digits (000 to 359)
- the approximate track absolute altitude in 100 ft increments with two digits, dot, one digit (e.g. 20.5 equals 20 500 ft); if less than 100 ft, 0.0 is displayed.

If the track is lost by the system the extra information for the track is removed and extra information for the highest priority track is displayed in the AF right ROL. If the target is lost by the system the extra information for the target is removed and the following targets move up in the DTL. The extra information for the next target is displayed.
Priority track information is displayed in the AF ROL when:

- the Default key on the AF is pressed
- a track is established from a condition when there were no tracks
- the selected track is nominated as a target.

The Elevation format shows only one ROL, depending on selection. If the track is lost the AF right ROL displays priority data as described above and the EF ROL is occulted.

Even more extra information on a track can be shown by XY insert on the track symbol on the PA format. A five-line page box is displayed adjacent to the track, and several "pages" of data may be available, depending on the nature of the track and the sources of available data. For example, there can be up to three pages (15 lines) of data displayable for a Friendly MIDS Joint User track. The extra info box is automatically occulted three seconds after the XY cursor is moved off the track symbol or the XY cursor is moved out of the box.

Attack Format ROLs

	LEFT ROL	RIGHT ROL
number one target in DTL available	number one target (automatically shown)	Second priority or XY selected track/target
number one target in DTL not available, and/or track lost, and/or no track selected	Blank	Highest priority track or XY selected track

To cancel the extra information of a track/target either press the Default key on the AF or select another track/target, or delete the track/target file.

Manual Deletion of Targets or Tracks

Targets or tracks, which tactically can be ignored, can be deleted when for example causing the automatic scan centering facility to scan in a non optimal scan volume.
The deletion of the track will only be temporary if the track is of sufficient priority and still detectable within the scan volume.
Target or track deletion can be done in TWS only and is achieved by "picking up" the Bin icon by XY insert on the bin, positioning the bin by XY over the required target or track, and inserting again.
Carrying out the same process on a target in the DTL this will only de-nominate the target back into a track. Then a second XY insert on the track symbol will delete the track file if it is derived from own sensors.
Normal moding of the XY cursor, and cancelling the denomination facility, is achieved by either inserting on a blank space or by inserting on the bin icon.

Sensor Management

Scan Volume/Center

In Air-to-Air search modes the radar scan volume (azimuth/elevation in RWS/TWS, velocity in VS) can

be adjusted with XY controller as long as the maximum frame time is not exceeded.
Note that there is no range selection for A/A modes beside the range selection on the Attack Format, which only selects the displayed range.
The following default scan volume is set after first radar switch on since aircraft power up:

– two bars
– maximum azimuth width
– elevation angle zero (horizon stabilized)
– 80 NM range scale in TWS on AF or
– maximum velocity scale in VS on AF.

The default volume is also accessed via the SK DFLT on the AF as well as on initial entry of the TWS mode.
On subsequent radar power up the previous scan volume parameters are used.
When the default selections are altered via PSMK this pre-defined default conditions will be restored.
The center of the scan area can either be adjusted manually or is set automatically when Auto Scan Centering facility (ASC) is selected.

Automatic Radar Scan Centering

In TWS mode an Auto Scan Centering facility (ASC) is available. This can be selected manually via the SK SCAN MAN/AUTO or is selected automatically when a track is nominated as target.
This enables the radar to automatically position the search volume in a way, where all actual search tracks can be optimally maintained. This means that the radar scan center in azimuth and elevation is automatically positioned to the geometric center of all current radar tracks, which can be seen on the MHDD formats.
When no targets are nominated the azimuth scan is set to its maximum width and the number of bars are set according to the range scale currently selected and adjusted when the range is adjusted as follows:

Automatic Radar Bar Setting

RANGE (NM)	NO. OF BARS
4-20	6
40	4
80	2
160-240	1

If the pilot manually modifies the radar scan center, ASC is automatically deselected. If no radar tracks are available the position of the radar scan center for ASC equals the last scan center position prior to the ASC selection.
Selection of Lock Follow will not cancel ASC, return to TWS will center on the last lock position.
If the last remaining track is deleted then the radar center remains space stabilized with respect to the scan center at the time when track was deleted.

Manual Radar Scan Control

Azimuth Scan Center

For all search modes the scan center can be moved by XY controller in azimuth and elevation within the radar gimbal limits. Insert anywhere within four mm of the scan volume line or centerline, slew as required, and insert to drop at the desired position. The scan volume will always remain symmetrical and when the radar gimbal limit is reached no further centerline movement is possible.
Any changes in the scan center will be reflected on the Attack, Elevation, and PA formats.
With radar at maximum azimuth scan width no centerline adjustment is possible.
When the radar is in warm up, in Passive or inhibited from transmitting, the line is shown dashed.

Azimuth Scan Width

The scan width (length of the bars) can be moved with the XY controller by inserting anywhere within four mm of either scan width line and slewing it to the desired angle. The scan width then alters symmetrically on both sides about the center line. A second insert will “drop” the scan coverage line at the desired position.
When the radar is in warm up, in Passive or inhibited from transmitting, the lines are shown dashed.

Elevation Scan Center

The elevation angle in relation to the horizon is controlled by the scanner elevation control wheel on the throttle top. The current radar elevation scan center is indicated on the AF top right corner with a positive or negative two digit number. Manual control is only active in VS, TWS and RBGM. In ACM or LF the elevation is controlled automatically, in SBY not acknowledged.

Elevation Scan Height

The elevation scan height (number of bars) is adjusted by selecting the white bar icon on the right side of the AF with the XY controller. Stepping through the number of bars (1, 2, 4, 6 or 8) is displayed with this icon. Default on initial power up will be two bar (unless PSMK defined). The scan coverage symbol length will vary with number of bars selected. Shortest with one bar selected and longest with eight bars selected. The radar bars will be positioned symmetrically about the elevation scan

center. When the radar is in ground mapping mode the length of the line will be fixed as for two bar scan.

NOTE

All manual scan settings may be cancelled quickly by selecting SCAN to AUTO or selecting DFLT on the AF.

Attack Computer

The Attack Computer (AC), located in the left avionics bay on the top shelf, performs the following processing for the attack and identification subsystem:

- correlation of sensor data
- identification of tracks and targets
- prioritizing of targets
- calculation of target positions
- calculation of weapon envelopes and Launch Success Zones
- calculation of steerings
- calculation for gun firing
- data support for missiles
- calculation for breakaway (Warning: Do not relay on radar derived information for safe separation)
- moding for sensors, weapon selection etc.
- interface to display and control subsystems.

It acts as bus controller on the attack bus and a remote terminal on the avionics databus, with the navigation computer acting as bus controller. If the navigation computer fails or is undergoing IBIT the attack computer takes over as reversionary bus controller on the avionics bus and in addition performs some of the navigation computer functions. If the aircraft is on ground (WOW) bus control of the navigation computer is automatically restored if the conditions, which generated the hand over, are reversed (e.g. completion of IBIT). In the air this return to the navigation computer is inhibited.

Attack Computer as Remote Terminal on AVs Bus (NAV Computer Bus Controller, Normal Condition)

As a remote terminal the attack computer:

- controls the operation of the Radar and the IFF interrogator selected on the MHDDs, LHGS and HOTAS
- controls the IFF transponder functions selected on the Left Hand Glare Shield (LHGS)
- monitors the IFF transponder operation and transfers the information to the LHGS and RHGS
- receives and controls an eject signal from the ejector seats, which erases any sensitive data stored in the computer
- controls the IFF IDentification Response selector on the RHGS. When the ID function is available the ID Response selector caption is illuminated, when operated the status bars above and below the ID Response selector caption are illuminated. The status bars extinguish when the IFF transponder stops the ID function
- receives release cues from the SCAC after weapon release.

Attack Computer as Bus Controller on the AVS Bus

As a Bus Controller the attack computer takes over the following navigation computer functions:

- CIU master/slave management (CIU NORM/ REV switch selections)
- CSG master/slave management (CSG NORM/ REV switch selections)
- Avionics and attack data bus health monitoring
- IBIT monitoring for LRIs connected to the avionics and attack databuses
- LRI failure warning generation for cockpit display.

Attack Computer Operational Software

The operational software of the attack computer breaks down in the following functional blocks:

A&I Subsystem Management

- Subsystem Moding
- Designated Target List
- LRI Health Monitoring.

Target Data Management

- Sensor Control
- Kinematic Data Fusion
- Identity Data Fusion
- Target Priorization.

Weapon Delivery Functions

- Air-to-Air Steering
- Missile Envelope Calculation
- Missile Priming
- Missile Flight Time Calculation
- Gun Aiming.

Attack Computer BITs

The AC performs three types of Built In Test:

PBIT

The PBIT is performed on power up and power interruptions exceeding 30 ms. The NOGO condition will be displayed on the MDP.

CBIT

The CBIT is entered on successful completion of PBIT and runs continuously during normal operations. Fatal faults will shut down the AC and initiate a CAT 3 warning, amber ATK CPTR caption on the DWP and audio warning.

IBIT

The IBIT is started by maintenance from the MDP for more in depth tests.

Bogus Weapons

To allow the pilot to train with a variety of different weapons and associated attack profiles, a "Bogus" weapon facility is provided within the Armament Control System (ACS). Air-to-air weapons are simulated within the ACS when the facility is enabled, and - in terms of moding and displays and controls response - the system behavior is almost identical to that when real weapons are carried.

Bogus weapons are only available when there are no "real" weapons carried on the aircraft. A mix of real and bogus weapons will not be accepted from the ACS. This also relates to the gun - bogus is not available if there are any gun rounds loaded. The only "real" stores that may be carried while still accessing Bogus are external fuel tanks and SRAAM training (acquisition) rounds or ACMI pods. Also, for Bogus to be available, the mission PDS load must be configured with bogus stores whilst on the ground, as must the Maintenance Data Panel (MDP). The ACS compares the PDS with the MDP on initialization, and will only provide Bogus if both configurations agree. Failures will be indicated on the MHDD Autocue and Stores format with an “all stores inhibit cross” and “red infilled boxes” at the affected store.

Bogus AMRAAM

Bogus AMRAAM missiles are decremented in accordance with simulated firing signals.

Bogus Gun

Bogus Gun requires that “zero rounds” are entered on the ground and therefore no simulated gun rounds decrement is available, i.e. rounds available will be indicated by a cross in the weapons block on the HUD and AF.

Bogus SRAAM

To achieve simulation of SRAAM, it is necessary to carry SRAAM training rounds, to permit missile acquisition and the resulting display of symbology and audio cues. Missiles are constantly available with no rounds countdown.

Normal Operation

A selected bogus configuration may be defined in mission planning and loaded by the PDS as well as via MDP. On aircraft powerup, once the ACS BIT and configurations checks are complete, the STOREs format shows the selected BOGUS configuration.

The bogus weapon (MRAAM, SRAAM or Gun) is selected via the weapon selector as per real stores. After firing, no reset is required for SRAAM or Gun as rounds do not decrement.

AMRAAMs are decremented and may be reset via the BGUS AMR MK, accessed via the MDE MISC SSK on the MDEF, refer to Figure 1.225. Bogus AMRAAMs are reset to the number of bogus AMRAAMS initially loaded, maximum six if no bogus SRAAMs are loaded on outboard stations. The BGUS AMR MK will occult when one or more missiles are in flight to prevent simulation of more than six AMRAAMs at one time.

Controls and Indicators

Display Declutter

De-clutter control of the CSG generated symbology on the ATK, AA-ATK, FLIR & ELEV and PA formats is implemented via the DCLT Softkey located on the ATK Format. The de-clutter level being indicated on the bottom of the key by the following legends: MAX indicates maximum De-Clutter level. NOR+ indicates normal De-Clutter level and that the next selection of the key will select MAX De-Clutter. NOR- indicates normal De-Clutter level and that the next selection of the key will select MIN De-Clutter. MIN indicates minimum De-Clutter level. Repeated selections of this De-clutter key cycle the de-clutter level through NOR+, MAX, NOR-, MIN, NOR+, etc. The default selection on entering any PoF (except Combat) is NOR-. On entering Combat PoF the default is NOR+ to ensure rapidl de-clutter of the head down formats.

Attack Format De-clutter

The main purpose of the Attack Format is to help the pilot prioritize targets, initiate attacks and complete the intercept. As this task is independent on phase of flight, Attack format symbols are subject to the same de-clutter logic in all mission phases. The following Attack de-clutter moding should be noted:

– On both the PPI and B-Scope formats all three weapons types (M, S & G) and stores remaining data blocks are displayed at MIN de-clutter. At NOR and MAX de-clutter only the currently selected weapon type and rounds/missiles remaining are shown.
– On the PPI display, all range scale digits are displayed at all de-clutter levels. On the B-Scope display only the maximum range digits are displayed at MAX de-clutter.
– Missile envelopes (Launch Success Zone) symbols on both the PPI and B-Scope are shown for the top six targets in the DTL at MIN and NOR de-clutter. At MAX, the envelopes are only shown for the first and second targets in the DTL when MRAAM is selected, or for the first target only when SRAAM is selected.
– When Bullseye has not been defined or the Bullseye grid is not selected a range and bearing read out is given for the XY marker with respect to PP. This own aircraft read out is occulted at MAX de-clutter.

PA Format De-clutter

As a result of being required to display both target and navigation symbology including the map display and it's associated tactical symbology, the PA format has the greatest potential to become cluttered. In addition more than any other format the type of information that is required to be displayed on the PA format changes with phase of flight, i.e.: During start-up and taxiing (i.e. Ground PoF) the primary task in relation to the PA format is the need to update navigation, route and tactical information.
During the take-off phase, navigation data is the focus, although radar data is also significant. In the navigation phase, route information (e.g. attitude, velocity and timing) is the primary focus. In the combat phases, sensor and weapons data becomes the prime interest. As identified above De-clutter control of the CSG generated symbology on the PA Format is actioned via the DCLT Softkey located on the Attack format. The effect of this key on the PA is summed up as follows:

– Unlike the Attack and Elevation formats, important data (tracks, etc.) may be located at the top edge of the format. To help to de-clutter this area the own aircraft height, speed and heading information is occulted at MAX clutter level.
– In all phases of flight a full weapons data block is displayed in all de-clutter levels.
– The HSI is not de-cluttered.
– Only the track line from PP to DWP, and the navigation route beyond DWP, are displayed in MAX clutter level.
– All other de-clutter rules that apply to the AF apply to the PA Format.

Tactical Information Level

In addition to the CSG generated navigation and combat symbology displayed on the PA format, the pilot can also select to display the DMG generated Map(s) and the associated Tactical Information. This Tactical symbology is categorized (0, 1 or 2) in the same way as the CSG symbology as detailed above but is de-cluttered both automatically and via pilot selection of the TACT Softkey as follows.

Automatic Tactical Information De-Clutter

When displayed with the CSG generated symbology set the amount and complexity of symbology available within the tactical data symbology set can result in excessive display clutter at the range scales >120 NM. In order to alleviate this clutter, automatic de-clutter has been implemented by either occulting or reducing the complexity of specific Tactical symbology as follows:

Automatic Tactical Information De-Clutter

SCALE (NM)	LINE FEATURE TEXT	ALT/TIME	CORRIDOR TEXT 5 KM	CORRIDOR TEXT 10 KM
120	Displayed	Displayed	Displayed	Displayed
200	Displayed	Occulted	Occulted	Displayed
320	Occulted	Occulted	Occulted	Occulted

Pilot Selectable Tactical Information

The pilot selectable TACTical Information Softkey works in a similar way to the DCLT Softkey on ATK format. However the following significant differences should be noted:

MAX indicates maximum information level (i.e. minimum de-clutter)
MIN indicates minimum information level (i.e. maximum de-clutter
For scales ≥200 NM, MAX Information is not available

At the 320 NM scale, both MAX and NOR Tactical Information levels are unavailable, resulting in the occulting of the TACT Softkey.

Elevation Format De-clutter

In common with the Attack Format, the Elevation Format is used primarily for target prioritization and engagement. EF de-clutter is therefore consistent with that of the Attack Format, and the de-clutter moding is the same for each PoF. As identified above, the DCLT Softkey located on the Attack format also de-clutters the Elevation Format.

HUD & HDH De-clutter

HUD and HDH de-clutter is controlled through a dedicated pushbutton on the HUP. As the HUD Format is the primary flight information display throughout all mission phases many of the symbols displayed on the HUD are flight or safety critical and so are never de-cluttered. However, unlike the MHDDs, where de-clutter is used to clarify the display of information, HUD de-clutter is necessary to allow the pilot to see through the symbology to the outside world. Of particular note are the following:

– In Ground, Take-off, Combat and Navigation PoF, the ±5°, ±15° and ±25° pitch bars are occulted when MAX de-clutter is selected. All other pitch lines and associated symbology are unaffected. However, all pitch bars are displayed in all de-clutter levels in Approach PoF.
– Only the currently selected weapon type and number remaining are displayed at NOR & MAX de-clutter.
– In Nav & Combat PoF the millibar setting is only displayed in the HUD when changed, and automatically occults five secs after the change is complete.
– In NOR and MIN de-clutter all targets (up to a maximum of eight) are shown in all PoF.
– In Combat PoF at MAX de-clutter, with SRAAM or GUN selected, only the first target is shown, while with MRAAM selected the first and second targets are displayed. At MAX de-clutter in all other phases of flight, the first and second targets are displayed.
– Three widths of heading ribbon are available. At MIN de-clutter a wide (55°) ribbon is displayed, at NOR de-clutter a normal (35°) ribbon and at MAX de-clutter a narrow (15°) ribbon.
– Bank angle marks and the VSI are displayed automatically as follows:

HUD & HDH De-clutter

DE-CLUTTER LEVEL	GROUND	T/O	NAV	COMBAT	A/L
MAX	VSI	B & VSI	B & VSI	Nil	B & VSI
NOR	VSI	VSI	Nil	Nil	VSI
MIN	Nil	Nil	Nil	Nil	Nil

HOTAS

XY-Controller Functions

The XY controller on the front of the right throttle is used for the following Attack and Ident functions:

– LF Manual Acquire (AF, PA and EF)
– Initiate Radar Tracks (AF and EF)
– Deletion of tracks (AF)
– Denomination of targets (AF)
– Extra Data on tracks and targets (AF, PA and EF)
– Management of DTL (AF)
– Nomination of tracks as targets (AF, PA and EF)
– Re-attack (AF)
– Bearing/Range Readout (AF)
– Allocate Missiles to Targets (AF)
– Azimuth scan volume adjustment (AF)
– Azimuth scan centerline adjustment (AF)
– Elevation multi-bar scan selection (AF)
– Manual RAID selection (AF)
– Own Aircraft Speed (KDAS/MACH) selection (AF)
– Active Scan in Radar Inhibit selection (AF)
– TGS Zoom function (AF and PA)
– Pilot Identity Override (PIO) (AF)
– RBGM Gain selection (AF)
– Radar Attenuation (AF)
– IFF Mode 4 Own Aircraft Response ON/OFF selection (AF)
– Manual IFF interrogation of tracks, targets or volumes (AF)
– Display Range scale changing (AF, PA, EF)
– Radar Altitude Coverage indication (AF, EF)
– SACQ sightline indication (HUD)
– SRAAM slave indication (HUD)
– Combination of SRAAM Slaved and Radar SACQ Mode (HUD)
– VISident position selection (HUD)

For detailed XY-controller operation refer to Surveillance/Attack and Identification pag. 1-471.

A&I XY Functions with Plots/Tracks/Target/TGS

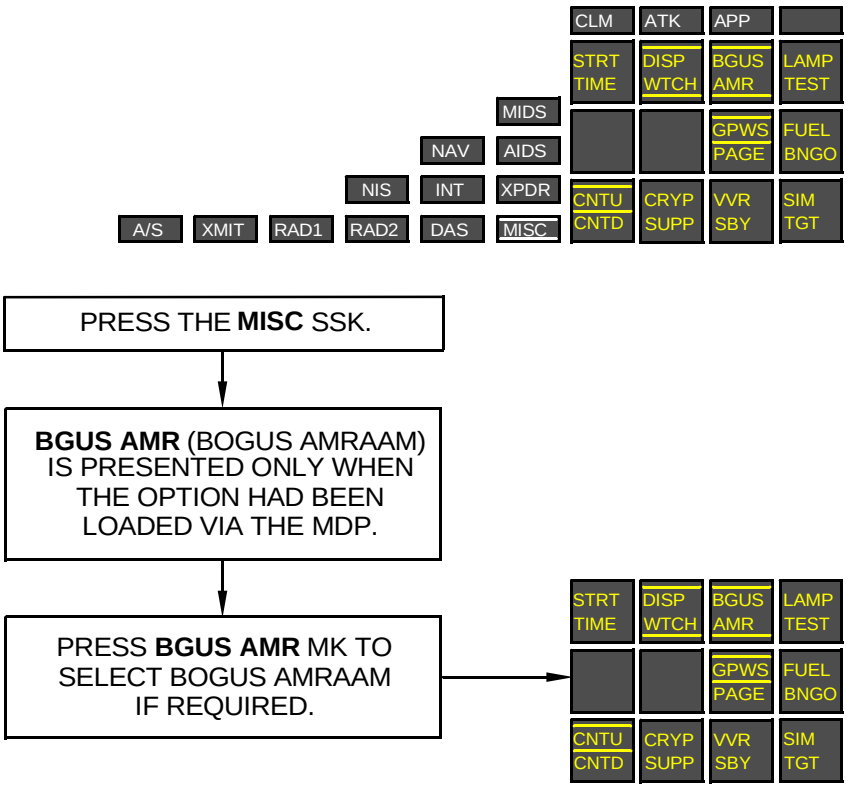
XY CONTROLLER/ MARKER	ATTACK FORMAT	PA FORMAT	ELEVATION FORMAT
position over track/target	magnetic lock-on to symbol (marker jumps on symbol when marker comes close to it), no other display change	magnetic lock-on to symbol, no other display change	magnetic lock-on to symbol, no other display change
position over DTL target	magnetic lock-on to symbol, displays extra data in ROL(s), occults after seven sec. or if XY is moved off symbol	magnetic lock-on to symbol, no other display change	magnetic lock-on to symbol, displays extra data in ROL
short insert on a plot	initiates a radar track	no plots available on PA format	initiates a radar track
short insert on track/target	displays extra data in ROL(s), and IFF info if available, and two-digit height on top right of symbol which occults after seven sec. or when XY is moved off symbol	displays extra info box (max three pages with five lines) which occults three sec. after XY is moved off symbol, and two-digit height on top right of symbol which occults after seven sec. or when XY is moved off symbol	displays extra data in ROL and two-digit height on top right of symbol which occults after seven sec. or when XY is moved off symbol
long insert on track/target	displays raid box	displays zoom box	(as for short insert)
short and long insert on TGS	displays TGS zoom box	displays TGS zoom box	TGS not available
long insert on area	initiates area raid	displays zoom box	(N/A)
second insert on track	nominates the track as a target	nominates the track as a target	nominates the track as a target
third insert on track	nominates the track as the top priority target	nominates the track as the top priority target	nominates the track as the top priority target
insert on bin icon, drag bin icon over track and insert	deletes TWS radar track (MIDS tracks may not be deleted)	(N/A)	(N/A)
insert on bin icon, drag bin icon over target (including top priority target) and insert	denominates target	(N/A)	(N/A)

DWP Warnings

The following warning is available for the Attack Computer:

Attack Computer Failure Warning

WARNING	CATEGORY	VOICE MESSAGE	DWP CAPTION	SUPPRESS CONDITIONS	SYSTEM ACTIONS	MISSION CONSEQUENCES
Attack Computer Failure	3	Attack Computer	**ATK CPTR**	during power up/down	NAV Computer takes over bus controll on the attack bus	Loss of all attack computer functions



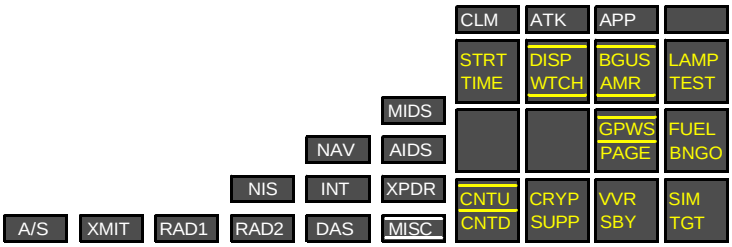
NOTE

THE PILOT MAY RESET THE AMRAAM TO THE INITIAL BOGUS STORES CONFIGURATION BY PRESSING THE **BGUS AMR** MK.

THE **BGUS AMR** MK OCCULTS WHEN ONE OR MORE 'MISSILES' ARE IN FLIGHT.

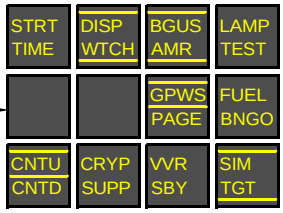
THERE IS NO DEK OR ROL MODING ASSOCIATED WITH BOGUS AMRAAM SELECTION.

Figure 1.225 - Bogus AMRAAM Selection



PRESS THE **MISC** SSK.

PRESS THE **SIM TGT** MK.



A SIMULATED TARGET IS GENERATED WHICH EXHIBITS THE FOLLOWING CHARACTERISTICS WITH RESPECT TO THE HOST A/C:
- SLANT RANGE 50 NM
- AZIMUTH 20° (LEFT)
- ALTITUDE 10000 FT (BELOW)

TARGET CONTINUES STRAIGHT AND LEVEL AT A GROUND SPEED OF 400 KT ON A RECIPROCAL TRACK TO THE HOST A/C AT INITIALISATION.

SUBSEQUENT SELECTION OF THE **SIM TGT** MK WILL DESELECT THE MODE.

NOTE

THE SIMULATED TRACKED TARGET MODE WILL AUTOMATICALLY DESELECT 360 SECONDS AFTER INITIALISATION.

Figure 1.226 - Simulated Target

Surveillance/Attack and Identification

(1B-B-93-00-00-00A-111B-A Issue 003)

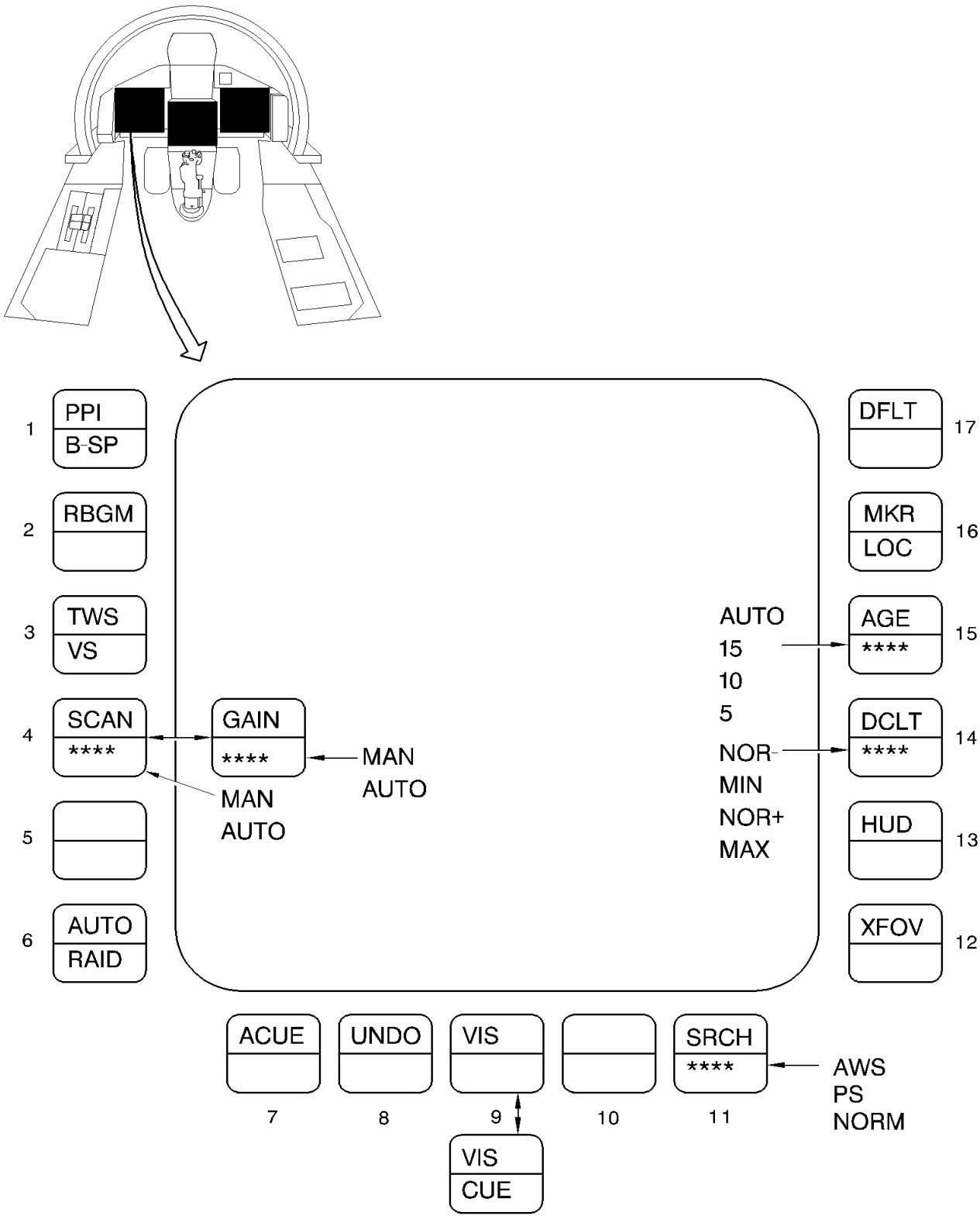


Figure 1.227 - Attack Format Soft-key Options

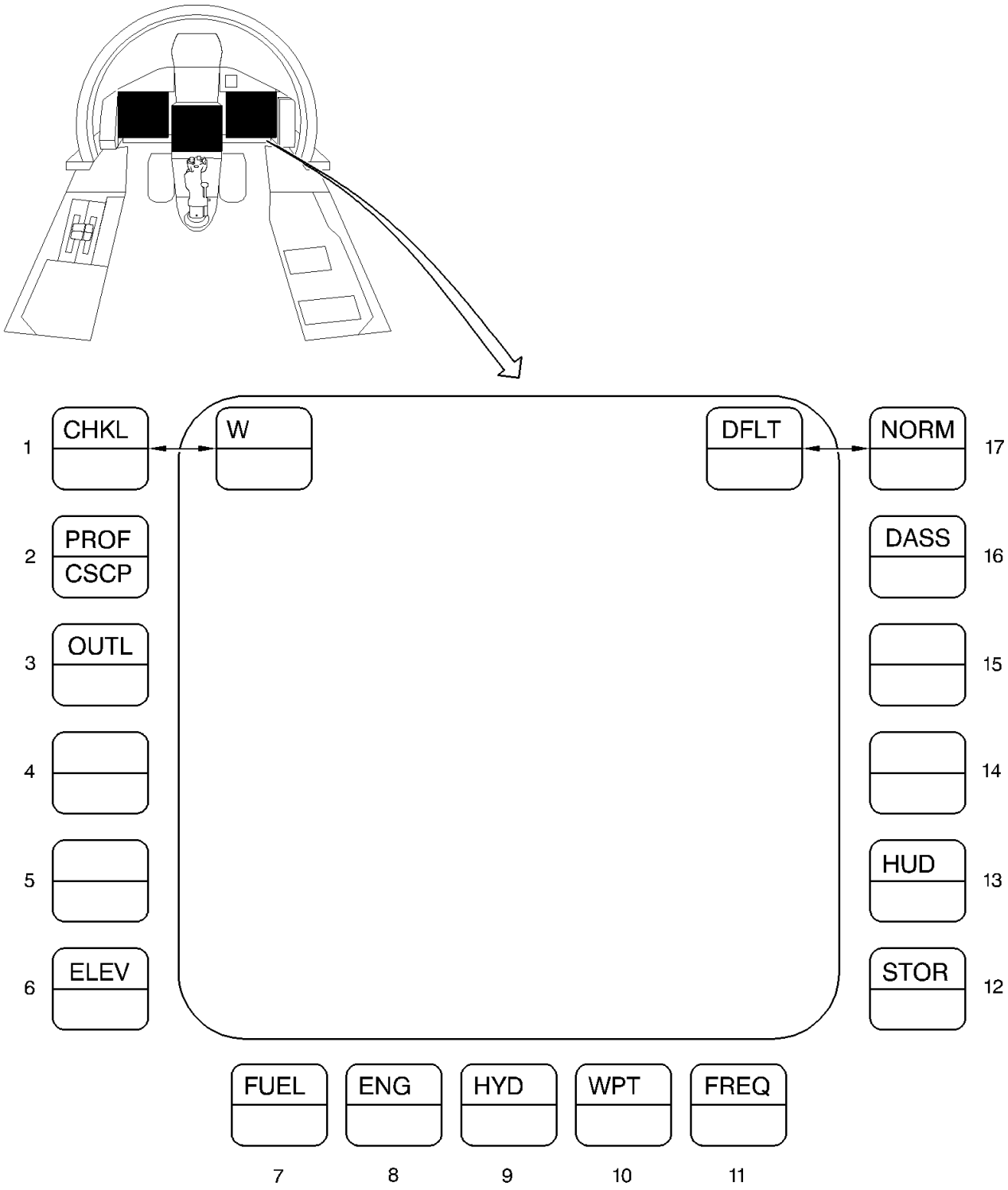


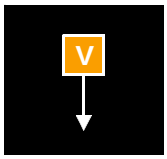
Figure 1.228 - Elevation Format Soft-key Options

FRIENDLY UNKNOWN HOSTILE
TRACK SYMBOLOGY

TCRI

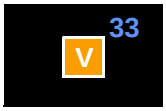
0-300 KTS 300-600 KTS 600 KTS +
VELOCITY VECTOR

DIRECTION OF TURN INDICATION



RAPID HEIGHT CHANGE

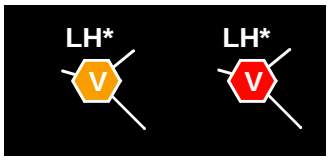
SYSTEM PRIORITY



ALTITUDE

RELATIVE ALTITUDE

MEMORIZED TRACKS AND TARGETS



TGS

TARGET NO.1 TARGET

Figure 1.229 - MHDD Track/Target Symbology

	FRIENDLY	UNKNOWN	HOSTILE
TRACKS			
MEMORIZED TRACKS AND TARGETS			
TARGETS			
FIRST TARGETS			
MEMORIZED FIRST TARGETS			

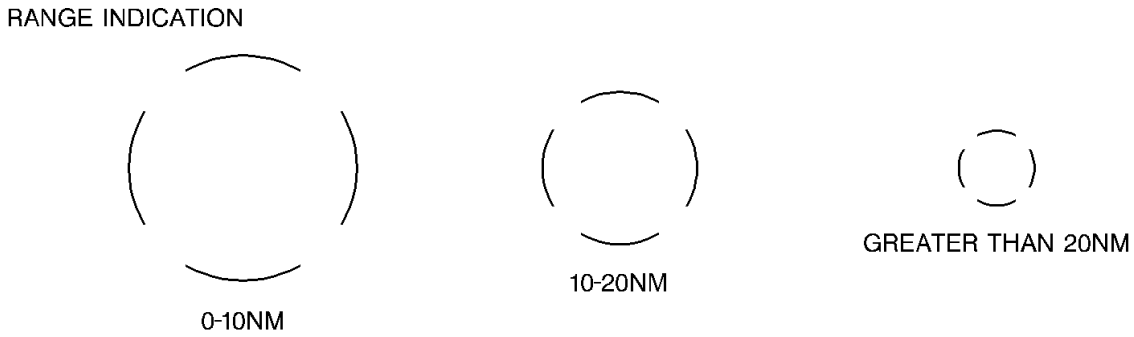
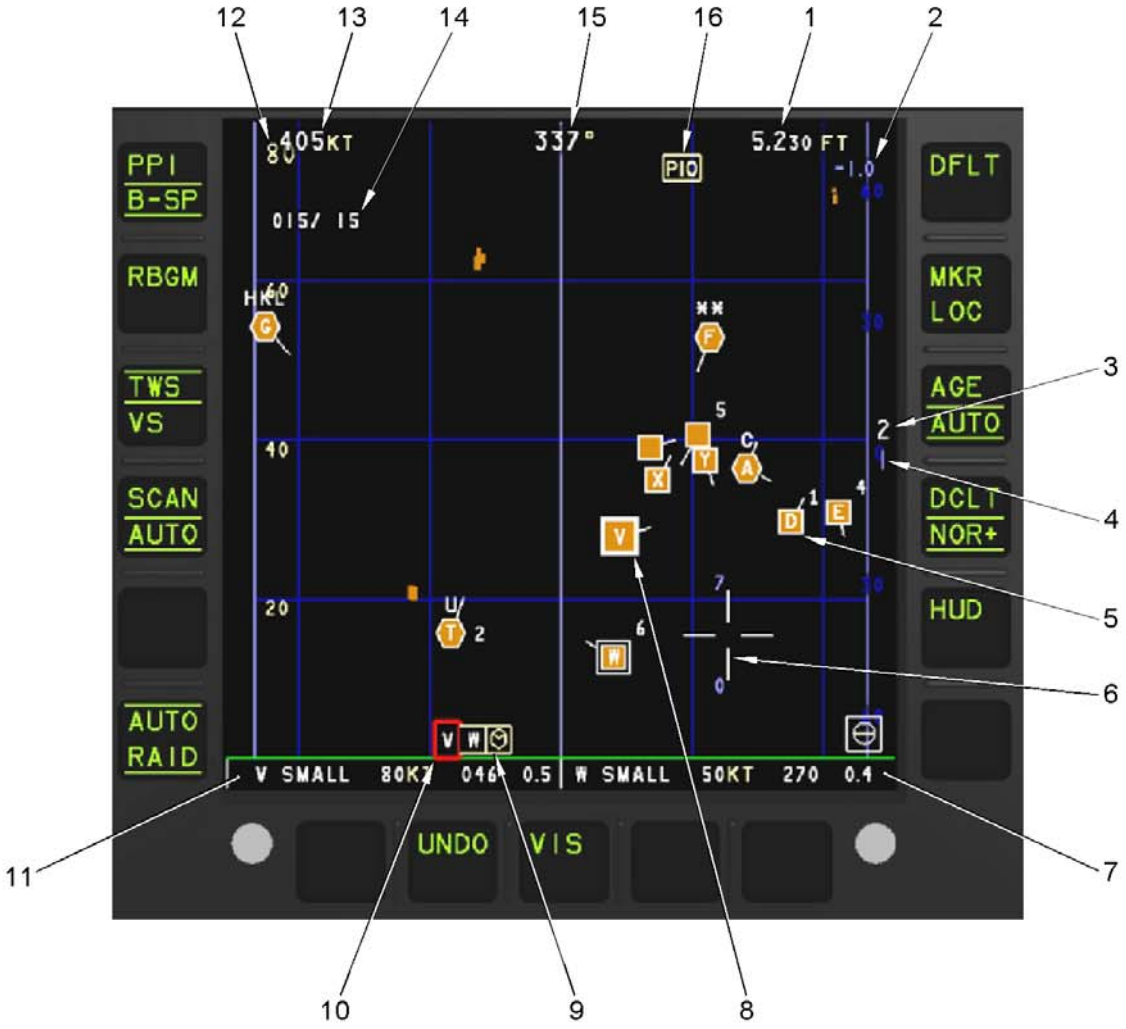
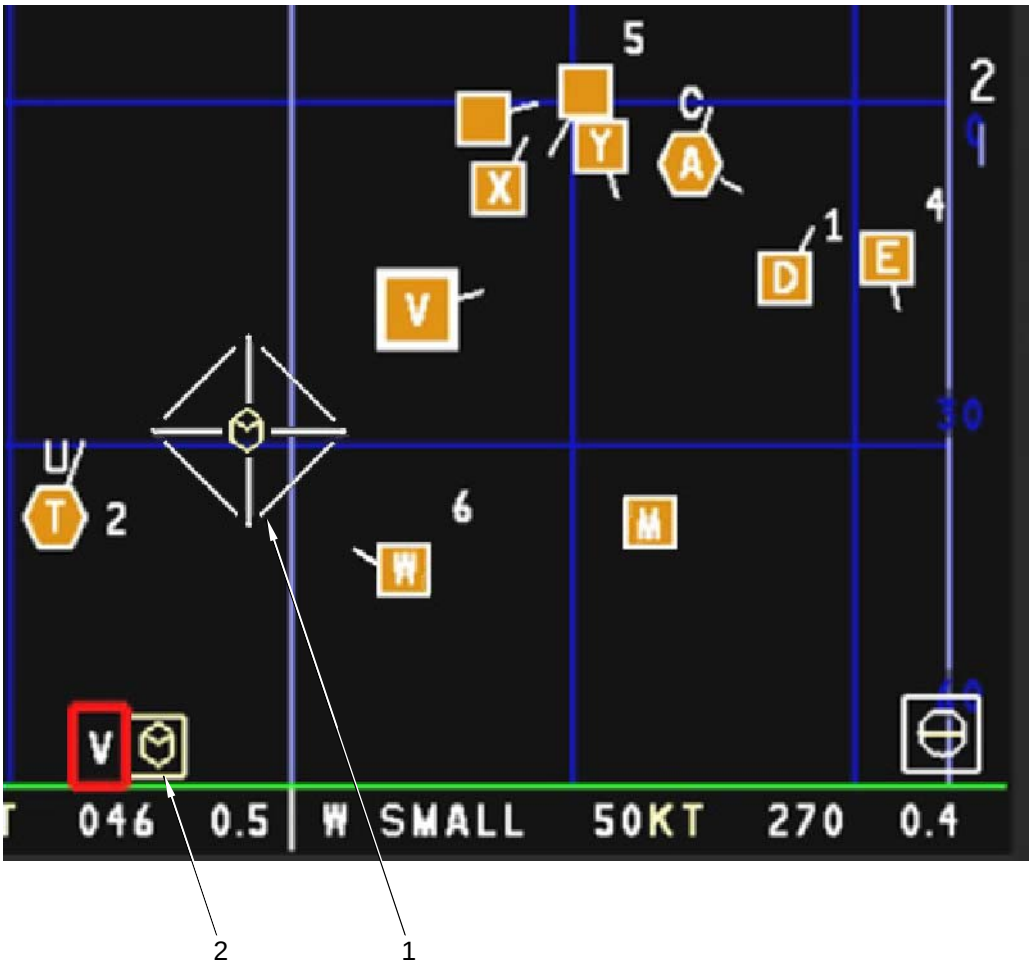


Figure 1.230 - HUD Track/Target Symbology



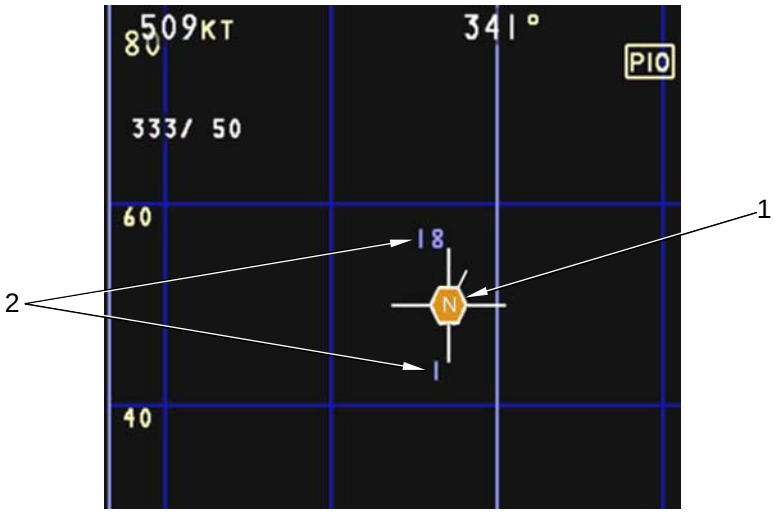
1 OWN AIRCRAFT ALTITUDE
2 DIGITAL SCANNER ELEVATION
3 SCAN BAR SETTING
4 ANALOGE SCANNER ELEVATION SETTING AND COVERAGE
5 SYSTEM DETERMINED NUMBER ONE TARGET
6 X-Y MARKER ANNOTATED WITH RADAR ALTITUDE COVERAGE
7 RIGHT ROL
8 NUMBER ONE DTL TARGET
9 "BIN" ICON
10 NUMBER ONE TARGET IN DTL
11 LEFT ROL
12 RANGE SCALE SETTING
13 OWN AIRCRAFT SPEED
14 BEARING AND DISTANCE FROM PP TO X-Y MARKER
15 OWN AIRCRAFT HEADING
16 PILOT IDENTITY OVERRIDE (PI0) ICON

Figure 1.231 - Example of Attack Format



1 X-Y MARKER IN TRACK DELETE MODE
2 TRACK DELETE ICON

Figure 1.232 - Attack Format - Track Deletion



1 TGS
2 RADAR ALTITUDE COVERAGE (1000FT)

3 PARAMETERS FOR SELECTED TRACK/TARGET
- TCRI
- SIZE
- TAS
- GROUND TRACK
- ALTITUDE (1000FT)

Figure 1.233 - Attack Format - B-scope TGS Zoom

1 WINDOW ON THE WORLD CANCEL
2 WINDOW ON THE WORLD ICON
3 FORMAT STABILIZATION SELECT
4 RADAR SCAN WIDTH INDICATION
5 X-Y MARKER WITH WINDOW ON THE WORLD SELECTED

NOTE
SOFT KEY (1) WILL DISPLAY RTN PP WHEN SOFT KEY (3) IS SET TO A/C STABILIZED. SOFT KEY (1) WILL DISPLAY RTN DWP WHEN SOFT KEY (3) IS SET TO GND STABILIZED.

Figure 1.234 - PA Format - Window on the World

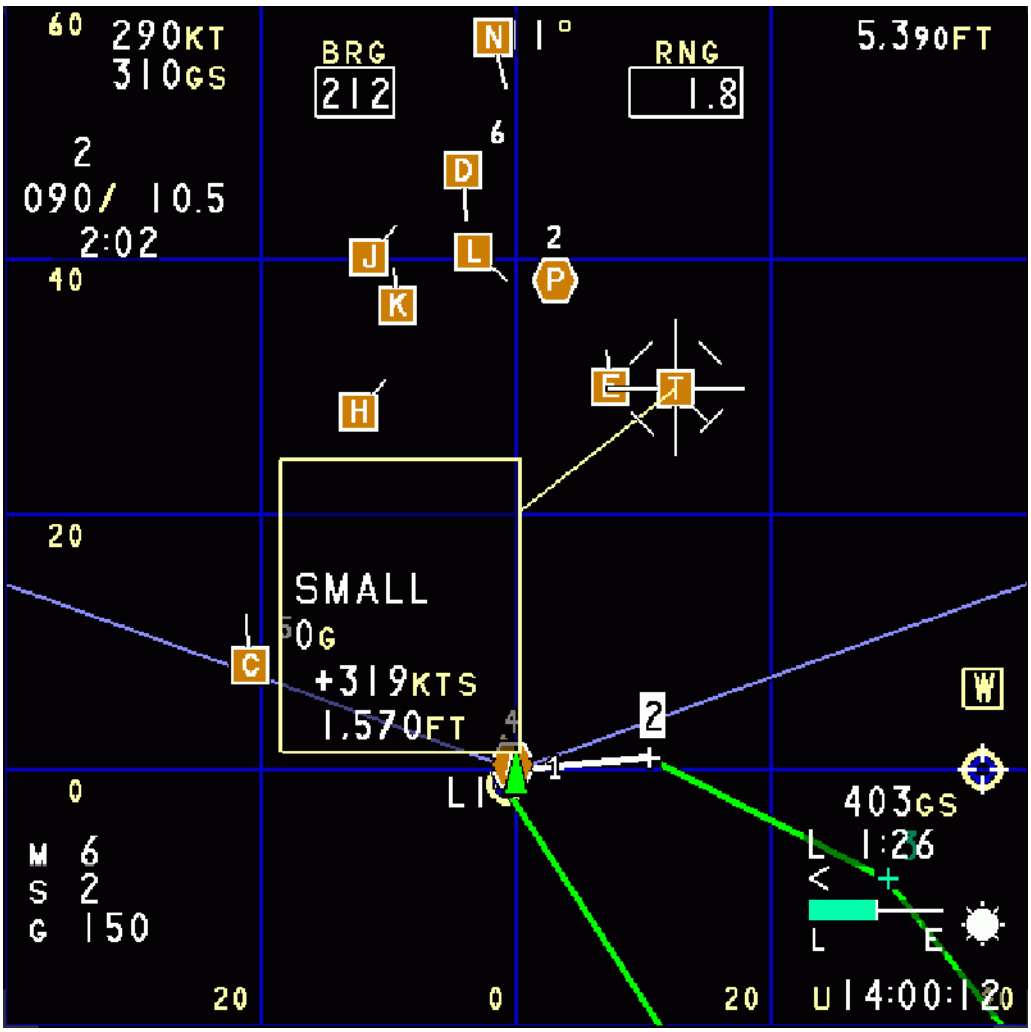
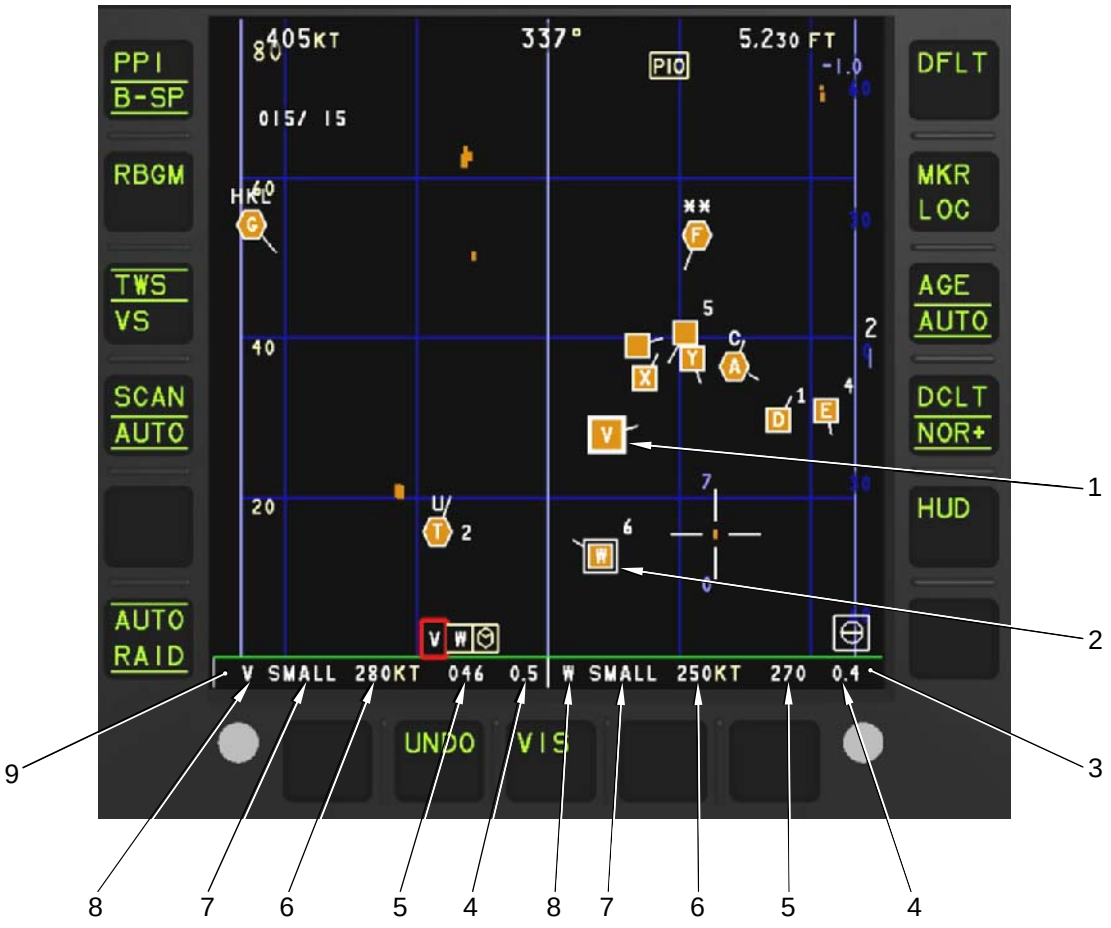


Figure 1.235 - PA Track - Extra Info



1 NUMBER 1 TARGET
2 NUMBER 2 TARGET
3 RIGHT ROL INDICATING SECOND TARGET OR REQUESTED TRACK/TARGET PARAMETERS
4 ALTITUDE (1000 FT)
5 GROUND TRACK
6 TAS
7 SIZE
8 TCRI
9 LEFT ROL INDICATING NUMBER ONE TARGET PARAMETERS

Figure 1.236 - Attack Format - ROL Target/Track Data

Radar

(1B-B-93-10-00-00A-043A-A Issue 005)

General

The Radar, also called “CAPTOR”, is the primary sensor for target detection, tracking and engagement. It is a pulse doppler multiple Pulse Repetition Frequency (PRF) radar with a high degree of automation of functions to minimize pilot workload and to provide optimum performance over a wide range of ambient and target conditions. The radar provides Air-to-Air (A/A) search, Lock Follows (LF) and Air Combat Modes (ACM) against Air-to-Air targets and Air-to-Surface (AS) mapping.

The radar supports the effective use of the Air-to-Air weapons and the 27 mm internal gun.

The automatic features of the avionics subsystem free the pilot to concentrate on the primary requirements of A/A combat, i.e. to detect the target, steer the aircraft and launch missiles or fire the gun. The Hands On Throttle And Stick (HOTAS) concept utilizes switches on the stick and throttle to allow the pilot to control the weapons, sensors and displays during time critical portions of the attack. After a target is visually detected, the pilot never needs to look away or remove his hands from the throttles and the control stick.

Radar acquisition is commanded from the control stick (Air Combat acquisition modes or manual acquisition mode). Attack steering information is automatically presented on the Head-Up Display (HUD) and on the Attack Format (AF) of the Multifunction Head Down Display (MHDD). The pilot uses the command steering cues on the HUD to get within weapon envelope and fires the gun or launches the selected missile with the trigger on the control stick.

The radar operates in conjunction with the IFF interrogator, associating the identification received with existing radar tracks.

Electronic Counter Counter Measures (ECCM) are built into the radar system.

Channel Operation

General

The radar can transmit either on

– fixed frequency mode, or in
– frequency agile modes.

The available radar channels and frequency modes may be pre-defined for each radar mode individually during mission planning and may be loaded on ground via PDS (SMD). The PDS will overwrite the previous frequency settings.

The radar channel may be amended also in the aircraft via MDE, the frequency modes may not.

Fixed Frequency Operation

The radar can use fixed channels (classified), which must be selected from the enabled (loaded) frequency set. If no channel set has been loaded then the full set of channels is available. The radar requires a minimum of two channels to operate therefore a channel pair (channel A and channel B) must be selected, with a defined channel separation (classified) between the channel pairs.

To reduce the effects of clutter, fixed frequency channels can be modified through the MDEF. When entering of a new channel pair is necessary, it must be considered that the channels are separated by a (classified) amount.

Frequency Agility (FA) Modes

The radar can operate in several Frequency Agility (FA) Modes (classified) on a loaded set of channels (known as the Enabled Set) defined during mission planning.

Pulse Repetition Frequencies (PRF)

For air-to-air operations, the radar provides detection, rapid acquisition and tracking capability for all aspects in look-up and look-down. This is achieved by automatically mechanizing different Pulse Repetition Frequency (PRF) modes, high (HPRF), medium (MPRF) and low (LPRF). Note, that there is no manual selection of PRFs, other than selecting a certain radar mode.

Scanning

Antenna Gimbal Limits

The radar antenna is electrical driven within +/-70° in azimuth and +/-60° in elevation. The azimuth and elevation limits are referenced to the fuselage reference line (FRL) of the aircraft.

The bars are overlapping a little bit to ensure scanning between bars without any gaps (refer to Figure 1.237).

Components

The Radar consists of the following subsystems (LRI's):

– Scanner (SCA)
– Processor (PROC)
– Transmitter Auxiliary Unit (TAU)
– Transmitter Power Amplifier (TPA)
– Receiver (RXR)
– Waveguide Unit

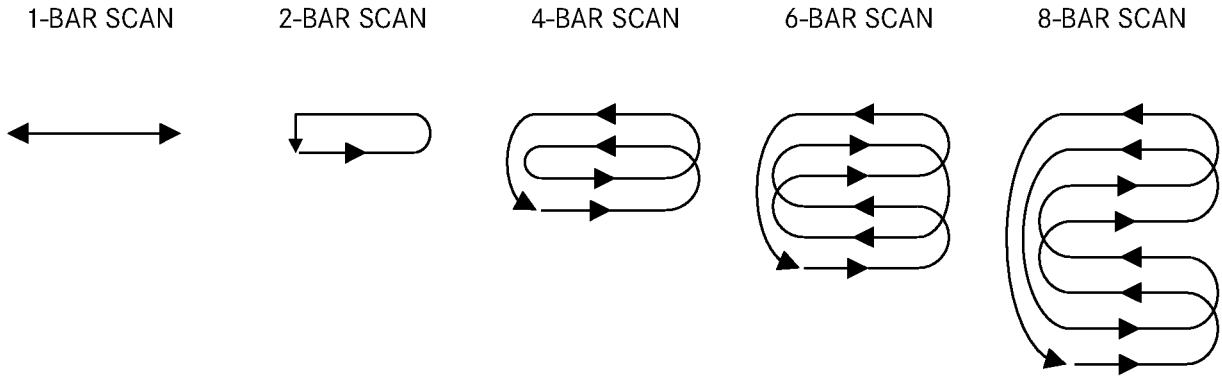


Figure 1.237 - Radar Bar Scan Pattern

Radar

(1B-B-93-10-00-00A-112A-A Issue 005)

General

The radar provides the following modes:

– Air-to-Air Modes (A/A), incl. Air Combat Modes (ACM)
– Air-to-Surface Modes (A/S), (RBGM only)

Air-to-Air Modes

The radar operates in the following air-to-air modes:

A/A Search and Track Modes

– Track-While-Scan (TWS)
  • Adaptive Waveform Scheduling (AWS)
  • Priority Search (PS)
  • Priority Tracking (PT)
– Velocity Search (VS)

A/A Lock-Follow Modes (LF)

– Single-Target-Track (STT)
– Visual Identification (VISident)
– Gun

Air Combat Modes (ACM)

– Slaved Acquisition (SACQ),
– Vertical Acquisition (VACQ),
– HUD Acquisition (HUDACQ).

Additional Moding

– Raid Mode
– Radar Stealth Mode
– Sector Acquisition (available at later aircraft standard)
– Non Co-operative Identification (NCI) (available at later aircraft standard)

Air-to-Surface Modes

– Real Beam Ground Mapping (RBGM)

A/A Search and Track Modes

In the air-to-air role the radar may search for tracks dependent on “range” or “velocity” detections, or may track detections taking both “range” and “velocity” into consideration.
Tracking not only involves association of previous detections with the present detection but also involves prediction of the track's next detected position. This enables velocity and range gates to be utilized increasing the accuracy of the tracking information.

Track-While-Scan (TWS)

TWS is the most important and most used radar search mode. It detects and automatically tracks airborne returns and provides outputs of track range, bearing, velocity, altitude, heading, approximate RCS and aspect angle. TWS can be entered directly by selection TWS on the MHDD/ATCK format from any other primary mode, i.e. VS. Any existing lock prior to TWS demand is broken and the radar starts TWS operation in the search state.

The TWS mode's primary function is to provide medium- to long-range situational awareness. TWS is required to provide simultaneous target detection and tracking over a large scan volume. The TWS mode utilizes raw hit detection data to construct multiple target tracks while the radar continues to provide a search capability. TWS multi-target tracking capability is determined by the trade-off between frame time and scan volume. The scan volume and scan center is manually definable by the pilot. The scan center is also controlled automatically by the radar when Auto Scan Centering facility (ASC) is selected or when a track is nominated as target.

When either Scan Centering (Auto/Manual) option is selected, and no targets are nominated, the elevation bars are automatically adjusted according to the selected range on the attack format.

With TWS selected the radar is capable of tracking up to 20 tracks and subsequently detecting and displaying 180 additional plots. When an object is detected and when the radar has sufficient data (i.e. the radar detects the object at least twice within four consecutive frames), it will form a track. The plots will `age' over a period of time and disappear. The ageing rate is normally controlled automatically by the radar, but may be varied by the pilot via soft key selection on the MHDD. An Automatic plot ageing time will equal to 2.5 times the scan volume time, enabling 2 or 3 plots to be displayed for each detected object.

In TWS the radar automatically controls the transmitted waveform (PRF) to provide optimum radar performance under a variety of conditions. For example, when looking down towards the surface, clutter rejection is enhanced by using a combination of medium and high PRF waveforms, while looking up uses a combination of medium and low PRF waveforms to optimize detection performance.

To optimize the operation of the TWS mode (PRFs) for either tracking or searching the following additional modes are implemented:

– Adaptive Waveform Scheduling (AWS), selectable via the SK SRCH-AWS/PS/NORM.
– Priority Search (PS), selectable via the SK SRCH-AWS/PS/NORM.
– Priority Tracking (PT), selected automatically by the system.

Adaptive Waveform Scheduling (AWS)

In AWS the radar uses waveforms optimized for target tracking accuracy and jamming resistance, whilst still maintaining a long range detection capability (refer to Figure 1.247). AWS is the default mode when TWS is selected, indicated on the SK SRCH/AWS with AWS boxed.

AWS is also used automatically in PT for the track excursion to the target.

Priority Search (PS)

In PS mode, the radar uses waveforms optimized for long range detection of new targets between existing tracks. It is expected that use of PS will allow target detection (displayed on the ATK format as plots) at greater ranges than in AWS, but tracking correlation and track maintenance may be less effective. PS is selected with the SK SRCH/AWS, which then shows SRCH/PS (PS boxed).

NOTE

PS is only available in TWS. PS is not available when the radar has entered PT.

Priority Tracking (PT)

After a target is nominated or engaged in TWS the radar automatically enters Priority Tracking, where up to six targets are updated with a higher rate (even when outside the actual radar search area, but within radar gimbal limits), which results in a more stable track and greatly reduces the workload associated with maintaining radar elevation coverage of nominated targets (refer to Figure 1.239).

Priority Tracking is mainly to support targets with AMRAAM in flight - in preference to other DTL targets.

In PT the radar uses also Data Adaptive Scanning (DAS), a facility which is entirely automatic within the radar, and is implemented whenever a nominated target moves outside the radar's elevation or azimuth scan volume coverage; in subsequent sweeps, the radar pauses momentarily at the target azimuth and the scanner is pointed briefly at the target's elevation, before continuing the set scan pattern. The resulting returns are used to maintain TWS tracking on the target.

Note that adaptive scanning is used only for up to six nominated radar targets. Non-target tracks will be lost by the radar if they move outside elevation scan coverage.

NOTE

The search priority option is not available when the radar is priority tracking.

To cancel Priority Tracking, denominate the targets or deselect TWS.

Velocity Search (VS)

Velocity search is used against targets with closure rates greater than own ship ground speed and therefore preferred against forward aspect targets. Generally, VS is used to detect long range targets.

VS provides target detection as a function of target velocity relative to the own aircraft velocity (doppler shift) and provides an output of closing speed and bearing. Target data is presented in a B-scope velocity-azimuth format as a `plot'. The plot will `age' over a period of time and disappear. The ageing rate is normally controlled automatically by the radar, but may be varied by the pilot via soft key selection on the MHDD. An Automatic plot ageing time will equal to 2.5 times the scan volume time, enabling 2 or 3 plots to be displayed for each detected object.

There is no tracking facility in this mode due to the lack of range information available although a plot can be selected for Lock Follow. If Lock Follow is achieved on a VS plot then the display will change to the default range format.

VS mode can be entered directly by selection VS on the MHDD/ATCK format from any other primary mode. Any existing lock prior to VS demand is broken and the radar starts VS operation in the search state.

A/A Lock-Follow Modes (LF)

General

Three lock-follow modes, which are optimized for their specific tasks, are available as follows:

– Single-Target-Track (STT)
– Visual Identification (VISident); if no weapon is selected
– Gun; if gun is selected as weapon type

In a Lock Follow mode the radar is locked to a single plot, track or target. This mode provides high accuracy positional data. If lock is achieved when GUN is selected, the radar enters GUN Lock Follow mode when target is within the Gun mode max/min range (refer to Figure 1.243). Similarly if lock is achieved when VISident is selected, the radar enters VISident Lock Follow mode when the target is within the VISident mode maximum range (refer to Figure 1.244). If neither GUN nor VISident is selected then Single Target Track (STT) is entered.

Single-Target-Track (STT)

STT is a lock-follow mode that can be selected manually from any search mode (stick top ACM control) or - following an air combat mode selection - automatically. For manual STT initiation, the pilot positions the XY marker over a plot, track, target or display position of interest and presses the RACM/ lock button. If lock is achieved, the track symbol is bracketed by a diagonal cross on the MHDDs and HUD. This radar functionality is also called “External Acquisition”.

When the radar has acquired an airborne target and has entered the LF mode STT it continuously tracks the target in range, angle and range rate. Upon uncommanded loss of lock an automatic re-acquisition is initiated (Figure 1.238). If the re-acquisition fails the STT mode is terminated and the radar continuous to operate in the primary mode in which the lock was achieved.

Within a lock-follow mode parallel searching and tracking of other targets is not possible. Therefore if a lock follow mode was entered from TWS mode (except via an Air Combat Mode - ACM) then the existing TWS tracks will “go into memory”, because the radar then will only be tracking a single object. If the radar stays in the Lock Follow mode for a period of time the memorized tracks will be automatically deleted. Note, that the DTL/PETL will be occulted when there are no designated targets anymore.

If lock-on is attempted within an Air Combat Mode (ACM), but not achieved, the radar remains in the selected RACM until deselection. If lock is achieved, but then lost, the radar will attempt to re-acquire for about two seconds, and then revert to the previous search mode (or RACM mode, if used to initiate lock) with the elevation and (where relevant) azimuth coverage centered on the last known angular position of the track.

When the radar is in STT, the scan volume controls and elevation bar option selections are not available on the ATCK format, and the radar volume will be occulted on the EF. Range scale options are available, however, during STT, automatic range scale adjustment is enabled.

VISident Mode (VIS)

WARNING

DO NOT RELY ON RADAR DERIVED INFORMATION FOR SAFE SEPARATION.

VISident is a short range lock-follow mode, providing radar steering to the locked target for visual

identification, down to minimum radar range without endangering the aircraft.
It is only available when the radar is in STT, although the mode can be pre-selected with the VIS softkey on the MHDD/ATCK format when in TWS or STT. Pre-selection, indicated on the softkey, allows to set up the required offsets.
When VISident is selected the positioning cue is displayed on the HUD, with the last selected position indicated on the cue, enabling acceptance of this position via a single selection. If no previous selection was made the default position of 6 o'clock on the smaller cone is used.
One of 12 positions can be defined on one of two fixed diameter cones about the target. The cones have 30° and 50° semi-angles subtended from the design eye position. The required offset position is defined by selecting the VISident soft key. The HUD displays two concentric circles and the X-Y cursor. The cursor can be slewed round the cones by X-Y inputs, and a short insert changes the cursor from one cone to the other; the desired position is then fixed in the system by making a long insert. This position can be preselected from TWS or STT, or updated any time when in VISident mode. The new position is indicated for 5 seconds and then the positioning cue is occulted from the HUD (refer to Figure 1.245).

NOTE

VISident is a “Head Up” visual mode and therefore the cones are only displayed in the HUD.

If VISident is preselected and a lock-on is achieved outside the VISident range then lead collision or pure pursuit steering will be provided until the maximum VISident range is reached (refer to Figure 1.246). Within the maximum VISident range, then VISident mode will be entered and the steering will then be lag pursuit to the selected VISident position (refer to Figure 1.244).
If the radar is not locked, with VISident pre-selected, the VISident circle and associated range rate cue are occulted, the steer dot provides pure pursuit steering, and only target range, range rate, and a TD box are displayed on the HUD.
If the lock-on is achieved the VISident target information is displayed and will include:

– closing/opening speed (digital & analogue)
– range to target (digital & analogue),
– altitude,
– course (track),
– minimum VISident range,
– minimum radar lock range and air speed,
– min range cross,
– aspect angle.

The range countdown to the target is displayed with an additional closing speed readout when the target range is less than 2 NM. The range countdown will indicate the minimum VISident range of 200 meters. VISident symbology will be provided below this range until radar lock is lost.
The aspect angle of the target is displayed on the HUD with the track sightline indication.
The HUD is automatically decluttered, (general navigation information is occulted).
If a weapon was selected prior VISident selection, the weapon is automatically deselected.
VISident is cancelled with:

– Deselect VIS softkey.
– Break Lock (pre-selection is still active)
– Weapon Selection (also deselects the pre-selection)
– Select another radar mode (VISident preselection will remain selected if this is TWS and will be cancelled if this is SBY, RBGM, VS or ACM).
– Standby

All indications will remain on the HUD until the radar lock break occurs.

Gun Mode (GUN)

The Gun mode is selected either by selecting Lock On when GUN as a weapon is selected or by selecting GUN when radar is in a Lock Follow mode. When selected and within maximum Gun mode range, the mode behaves as STT mode and provides data to support gun steering and aiming information.
When within (classified) range, the director gunsight is displayed and the steer dot is occulted (refer to Figure 1.243).
With the target at greater than (classified) range and the radar locked the radar deselects the Gun mode and enters STT. The steering dot gives fighter/target collision steering; the director gunsight is occulted, but the historic tracer line is displayed on the HUD.
When the target is just at the boundary, hysteresis is applied to avoid toggling between these two states.
To cancel the Gun mode break lock on or deselect gun.

Air Combat Modes (ACM)

General

The radar air combat modes are designed for the short range, air combat maneuvering, where rapid automatic radar acquisition and lock on of a visually detected target is desired. This radar function for this modes is called “Auto Acquisition”.
The following radar air combat modes are available:

– Slaved Acquisition (SACQ),
– Vertical Acquisition (VACQ),
– HUD Acquisition (HUDACQ).

The radar air combat modes (RACM) are selected via the HOTAS ACM button. When selected, the radar attempts to lock on the first detection within the search volume. The displayed scan volume is occulted from the attack, elevation and PA formats.
If no lock is achieved, the radar continues to search in the selected ACM mode, looking for targets.
If lock is achieved and then lost, the radar continues to search around the last known target position for a short time before it continuous to search in the selected ACM mode.
If the radar locks to an undesired target, then reselection of the ACM will break lock on that target (bump acquisition) and reject it for about two seconds, while the radar searches in ACM acquisition for further targets. The system re-initiates the selected ACM re-commencing the scan pattern from the rejected target position, or the boresight position for SACQ mode, if SACQ mode is the ACM mode. If no lock to a different target can be achieved during this period the radar re-enters the ACM acquisition state (refer to Figure 1.238).
Once lock is achieved the radar enters STT or GUN, if this weapon is selected. If a weapon is not already selected, the system will automatically select an SRAAM, if available.
The radar ACM modes can be entered directly by selection from any other primary mode. Any lock existing prior to the ACM modes is broken. Radar tracks will go into memory and delete when the track file is no longer valid and the plots will be occulted.
An ACM selection over-rides all other display and radar selections on the attack- and elevation formats. The search mode, from which the ACM was selected will remain on the softkeys (except from RBGM, in this case the last selected A/A search mode will be shown on the soft key).
ACM modes can be terminated by selection of another radar mode. Selecting the break lock function will return the radar to the last selected A/A search mode (also if previously mode was RBGM).

Slaved Acquisition (SACQ)

The SACQ is a narrow acquisition mode, selected by pushing forward on the radar ACM select button on the control stick.
When SACQ mode is selected the radar antenna is initially aligned with the aircraft boresight axis, i.e. the scan volume is adjusted to the 3.1 deg by 3.1 deg around the commanded scan center, indicated on the HUD by a 3° diameter reference circle centered on the aircraft boresight axis (refer to Figure 1.242).
The radar scan center can then be slaved with the XY controller or may be combined with the AIM-9L seeker head (SRAAM Sensor Slaving). While radar SACQ mode is engaged, the annotation “HUD” is shown at the marker locate position (next to the MKR LOC softkey) on the AF. When SRAAM Sensor Slaving is selected the reference circle will appear on the HUD at the seeker heads position which is then the position the radar is looking at.
If bump aquisition, i.e. re-selection of SACQ, is selected, e.g. because the radar has locked to an undesired target, the radar antenna is aligned with the aircraft boresight axis again.
The upper range gate is set to 15 NM.

Vertical Acquisition (VACQ)

The VACQ mode is selected by pushing aft on the radar ACM select button on the control stick.
The radar is commanded to a 2 bar elevation scan pattern from at least -15 deg to +60 deg elevation (refer to Figure 1.241). The azimuth scan coverage will be at least 6.2 deg around the boresight axis. The upper range gate is set to 15 NM. VACQ is weapon independent and takes priority over weapon initialized parameters.
This mode is preferably used when flying with high AoA and high roll rates to search in the upcoming flight path.

HUD Acquisition (HUDACQ)

The HUDACQ mode is selected by pushing to the right on the radar ACM select button on the control stick.
On selection, the scan volume (8 bars in elevation) is adjusted to the HUD fields of view which is 30 deg in azimuth (+/-15° right/left) and 25 deg in elevation (+7,5° up, -17,5° down) (refer to Figure 1.240). The upper range gate is set to 15 NM.

Additional Moding

Manual Raid Mode

A Raid assessment facility is provided within the radar, in which the radar processes the detected radar returns to determine if more than one aircraft or object is present within the detection. Raid improves the range calculation by optimized PRFs and other special radar technics to optimize target resolution. When Raid is selected 75% processing time of a radar scan is used for the normal radar processing and 25% for the Raid processing.
RAID can be selected manually any time with a long XY insert on a track, target or blank area (volume). The facility is only available on the AF when the radar is in TWS or Lock Follow modes.
Any plots detected during manual Raid are displayed with their corresponding 2-digit altitude, as for normal tracks following XY insert. Tracks within the RAID or AREA boxes may be nominated as targets

and weapon aiming initiated against them. Therefore information required to enable an attack to be carried out will be displayed with the RAID picture. This will be DTL, weapons remaining, time to autonomous, time to release and the shoot cue.
Tracks within the RAID or AREA boxes may also be de-nominated, using the BIN and UNDO XY functions.
It is not possible to select manual track initiation, alter the selected number of bars, adjust the radar scan width or azimuth center or change the attack format range when the RAID picture is displayed. The symbols associated with the control of these functions are occulted.
The zoom function is also not available when RAID is selected.
The underlying attack format range and the position of the center of the RAID picture is displayed with the RAID picture.

Raid on a track

Manual Raid on a track is carried out by positioning the XY cursor over the track symbol on the Attack Format and making a long (greater than one second) XY insert. The AF changes to show the Raid Box, a 5 x 5 NM square expanded display centered on the selected track; the display is similar to the TGS expand box, and is differentiated by the legend "RAID TRACK 5" in the top right corner of the display. The “5 “indicates the size of the raid picture (5 x 5 NM). Like TGS expand, a small square shows the position of the expanded box on the underlying range scale, to assist in maintaining situational awareness. Returns produced by the raid processing are displayed as plots - they age in the same way as plots on the normal formats; any tracks that are within the expanded box coverage will also be displayed. The Raid display is cancelled by XY insert anywhere inside the RAID assessment box (provided no symbol is captured with the XY marker) or when any other format is selected. In addition, the number of aircraft or objects detected within the track by the raid process (if greater than one) is displayed as a number in a small box (up to two digits, leading zero occulted) to the bottom left of the track symbol on the PA and elevation formats.

Raid on an area

The manual RAID on a volume function is only available in TWS.
Manual Raid on an area is carried out by positioning the XY cursor on the AF at the center of the area of interest and making a long XY insert. The AF changes to show the 5 x 5 NM square raid box, but this is now aircraft stabilized. It is differentiated from the track stabilized Raid box and TGS expand box by the legend "RAID WINDOW 5" at the top right corner of the display. Because it is aircraft stabilized - i.e. it "snowplows" a constant range and bearing ahead of the aircraft - any moving returns (shown again as plots and/or tracks) within the box coverage will move across the display. If the raid plots are associated with a radar track, the number of objects within the track is also displayed on the PA and elevation formats.

Radar Notch Selection

The Radar cannot detect tracks within ground clutter unless their component of velocity in the direction of ownship is sufficiently great. This deadband area (radar notch) is a physical radar limitation.
Tracks moving just outside of the deadband can be detected.
As road traffic falls within this area, there is potential for a lot of tracks to be generated. This would lead to unacceptable display clutter, so when looking down the weapon system artificially extends this deadband area (radar notch). The radar can still detect returns within this extended notch, but will not attempt to form new tracks or output information on new returns within this area. If an existing track moves within this area it will be updated and maintained.
To allows the radar to detect low speed tracks when looking down, i.e. helicopters, the radar notch may be selected to LOW with the SK NTCH on the AF (reduced notch size with increased clutter).
The notch operation may also be controlled automatically by selecting the SK NTCH on the AF to AUTO. Then it will operate with a larger notch when looking down (to reduce ground clutter) and a smaller notch when looking up.
The NTCH SK is not available when the radar is in OFF, SBY, PBIT, VS, LF, or any A/S modes.

Radar Mode Transition After Takeoff or Landing

On ground the radar automatically enters the SBY mode after switch-on and warm up. On T/O, weight-off-wheels, the radar is automatically put into the TWS mode, provided no other radar mode, e.g. VS has been pre-selected. Radar transmission after weight off wheels is inhibited when Radar Silent (RDR SLNT) has been preselected by the relevant MK on the LGS.
On landing the radar enters automatically the SBY mode.

Radar Safety Interlocks

If weight is on wheels, either left or right main landing gear, all radar emissions are inhibited. This inhibit function may be overridden by groundcrew for testing via the Weight on Wheels Override switch.
If the radar liquid cooling fails all radar active modes are automatically disengaged. The pilot can override the overheat protection within 5 sec after cooling fail and force the radar to provide the active modes

again until a radar total failure occurs. The override function is selected with the Radar Protective Interlock Override switch on the left hand console and will be inhibited with WOWs. The overheat override status can be deselected again with the override switch.

Radar Stealth Mode

In Stealth Mode, SLNT selected on the MDEF, the radar antenna is parked in an position difficult to detect by hostile radars. No transmission or reception will be performed except a 'Significant Events' occurs (see below) or Active Scan icon (from PSC 2.0 onwards) is selected (see below).
For detailed description refer also to Transmitter Management pag. 1-592.

Active Scan icon

To leave the stealth mode the radar can be commanded to perform two active frame scans by selecting the Active Scan icon (from PSC 2.0 onwards) on the AF, using the XY controller. This temporarily breaks the inhibited status of the radar. The radar then searches for two full scan patterns with the mode and the volume selected prior to stealth selection.
A Two Active Frame Scan is not possible if the radar is in OFF, SBY, PBIT, ACM, LF, or RBGM prior to stealth inhibit selection.

Significant Events

In 'All Silent' and 'Program' mode, rapidly overridding of Transmit Inhibit for a particular system may be required, in order to cope with an urgent threat or emergency situation. This is catered for by the following 'Significant Events':

– Selection of ACM - this will engage the Radar in ACM, and allow normal IFF Interrogator operation. Deselection of ACM on HOTAS (i.e. by selecting 'break lock') will return the Radar and IFF Interrogator to 'stealth'. However, deselection by selecting another Radar mode, such as TWS, will initiate a 'Long Term Significant Event', whereby the Radar and Interrogator effectively leave 'stealth' permanently (until reselected as part of 'All Silent or 'Program' modes). In this case, Transmit Inhibit either changes to the 'Null' state, or removes Radar and Interrogator from 'Program' as indicated on the MDE controls.
– Selection of EMGY, or Eject - will activate the Transponder in Emergency mode. Deselecting EMGY will return to 'stealth'.
– Selection of ID - will activate the Transponder in Ident, provided the appropriate modes are selected. Afterwards, the Transponder will return to 'stealth'.

Radar forced Standby

The radar can self select a forced standby mode when it detects any internal problem or problems with data from the weapon system. The pilot will be alerted by the text “RDR STBY”, appearing at the bottom of the AF, above the ROL.

Air-to-Surface Mode

The radar will operate in the following air-to-surface mode:

RBGM	Real Beam Ground Map

Real Beam Ground Mapping

This mode provides a pitch-, roll-, and drift-stabilized radar map video on the Attack Format and is selected by the RBGM key. When selected with RBGM softkey, the radar changes into a mapping mode, the Attack Format changes to a PPI format (B-scope not selectable) and the track-oriented radar map is displayed as the radar sweeps. Deselection of RBGM will select the last A/A radar search mode.

Radar elevation scan is controlled manually, there is no automatic scanner pointing. The radar will automatically select between a one bar and two bar elevation scan depending on attack format range; there is no manual selection of scan bars. The elevation coverage and number of bars indications are not displayed on the AF in this mode.

The AF range will remain the same unless the range was greater than the maximum RBGM range, in this case it will become the maximum available RBGM range.

It is possible to alter the attack format ranges, scan width and elevation angle of the scan as for Air to Air operation.

Gain Control for RBGM (from PSC 2.0 onwards)

The receiver threshold of the radar is controlled via the radar gain function. It is either controlled automatically by the radar or manually by selecting the GAIN SK to MAN. A manual gain control selection icon appears on the AF. A XY insert on the icon will toggle the mode of the elevation wheel on the throttle top from scan elevation control to gain control and vice versa. The icon is contrast inverted (white background) to indicate when gain control is active. The gain setting is displayed as percentage (max=100, min=0) in the icon, the higher the number the higher the gain. The setting will stop at 0 and 100, i.e. the value will not wrap over. On selection the last automatic controlled value will appear. When manual control is selected the automatic function will be inhibited.

Attenuation Control for RBGM

The transmitter level of the radar is controlled via the attenuation icon using the XY controller. The attenuation value is displayed in whole number from 1 to 6. Default value of max power output is equal to 6 (0 dB), where minimum is equal to 1 (15 dB). Inserting on the upper chevron of the icon decreases the attenuation setting, i.e. increases radar power. Inserting on the lower chevron increases the attenuation setting, i.e. decreases radar power. The icon is contrast inverted (white background) to indicate when attenuation control is active. Long inserts change the values at a rate of two steps per second.

SEARCH/LOCK-FOLLOW MODING

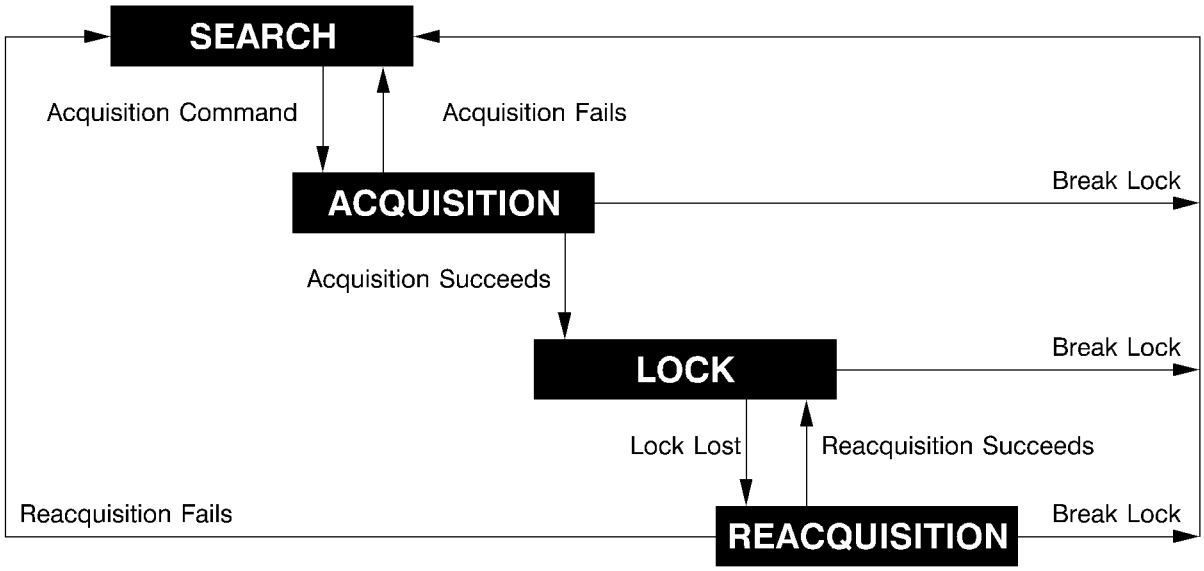


Figure 1.238 - Search/Lock-Follow Moding

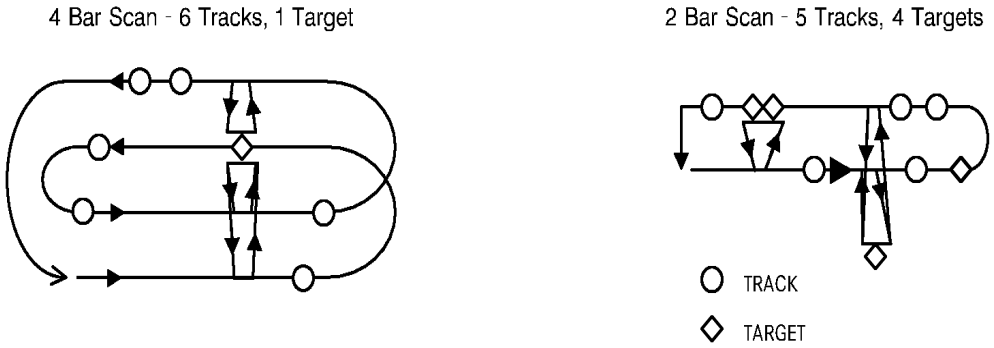


Figure 1.239 - Radar-Priority Track Mode (PT)

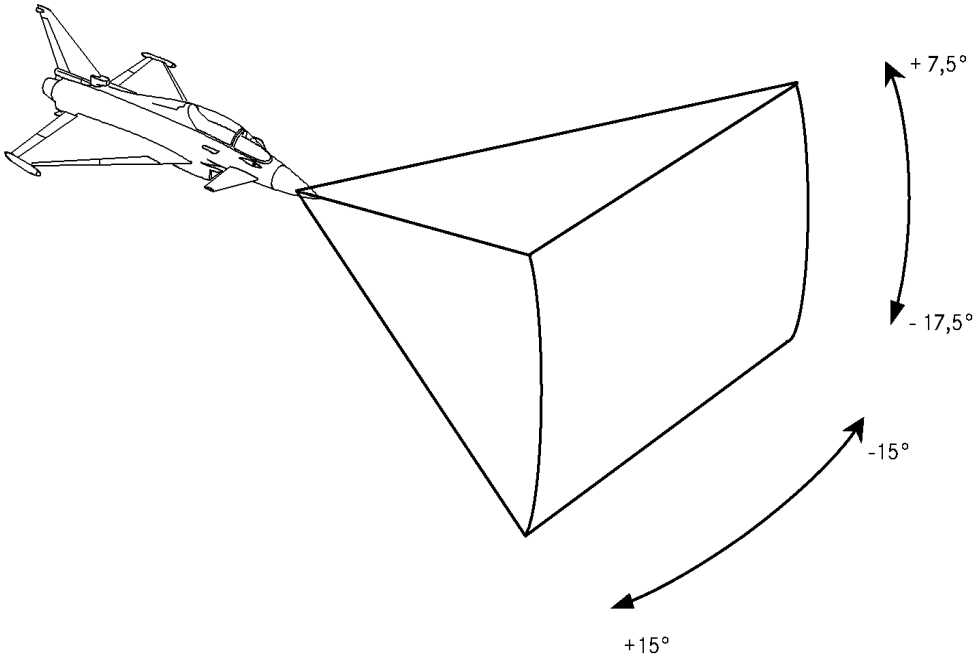


Figure 1.240 - Scan Volume HUDACQ

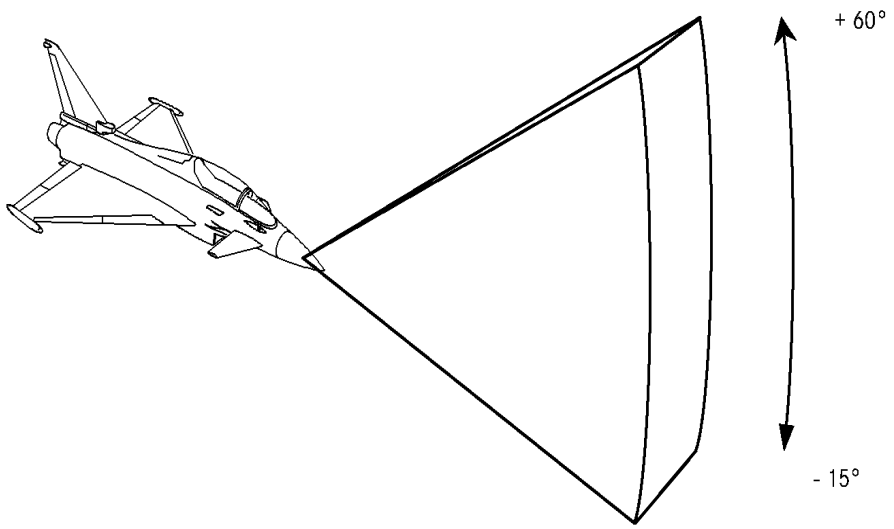


Figure 1.241 - Scan Volume VACQ

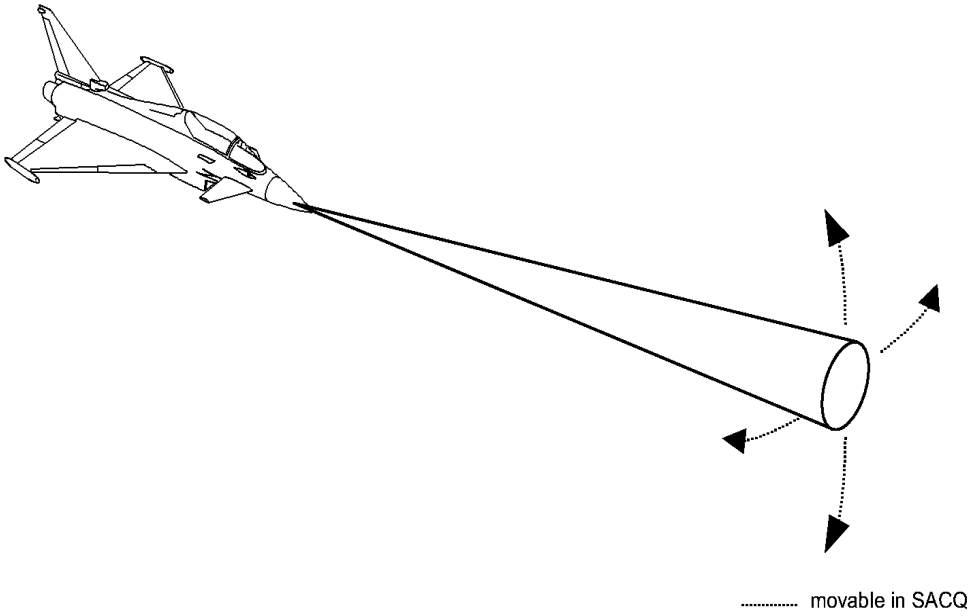


Figure 1.242 - Scan Volume BSTACQ/SACQ

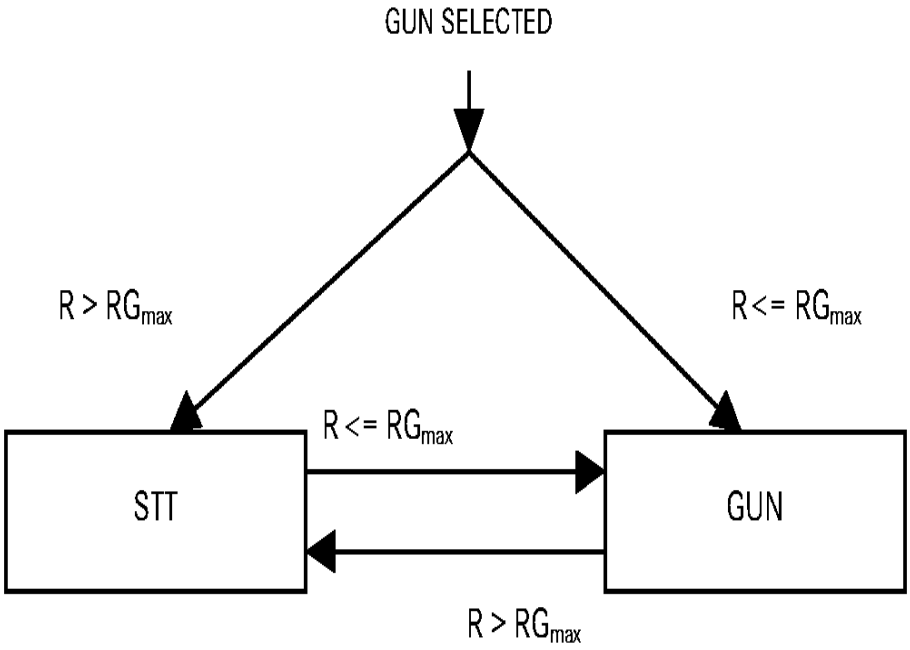


Figure 1.243 - STT/Gun - Moding

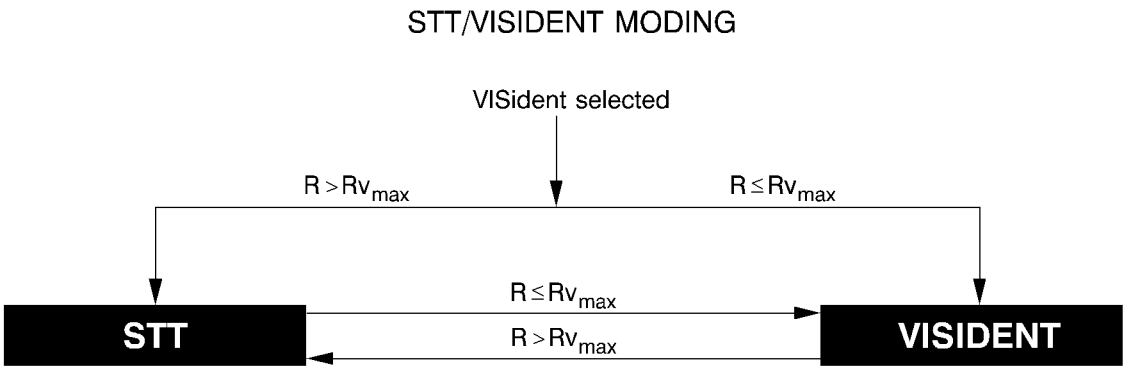


Figure 1.244 - STT/VISident - Moding

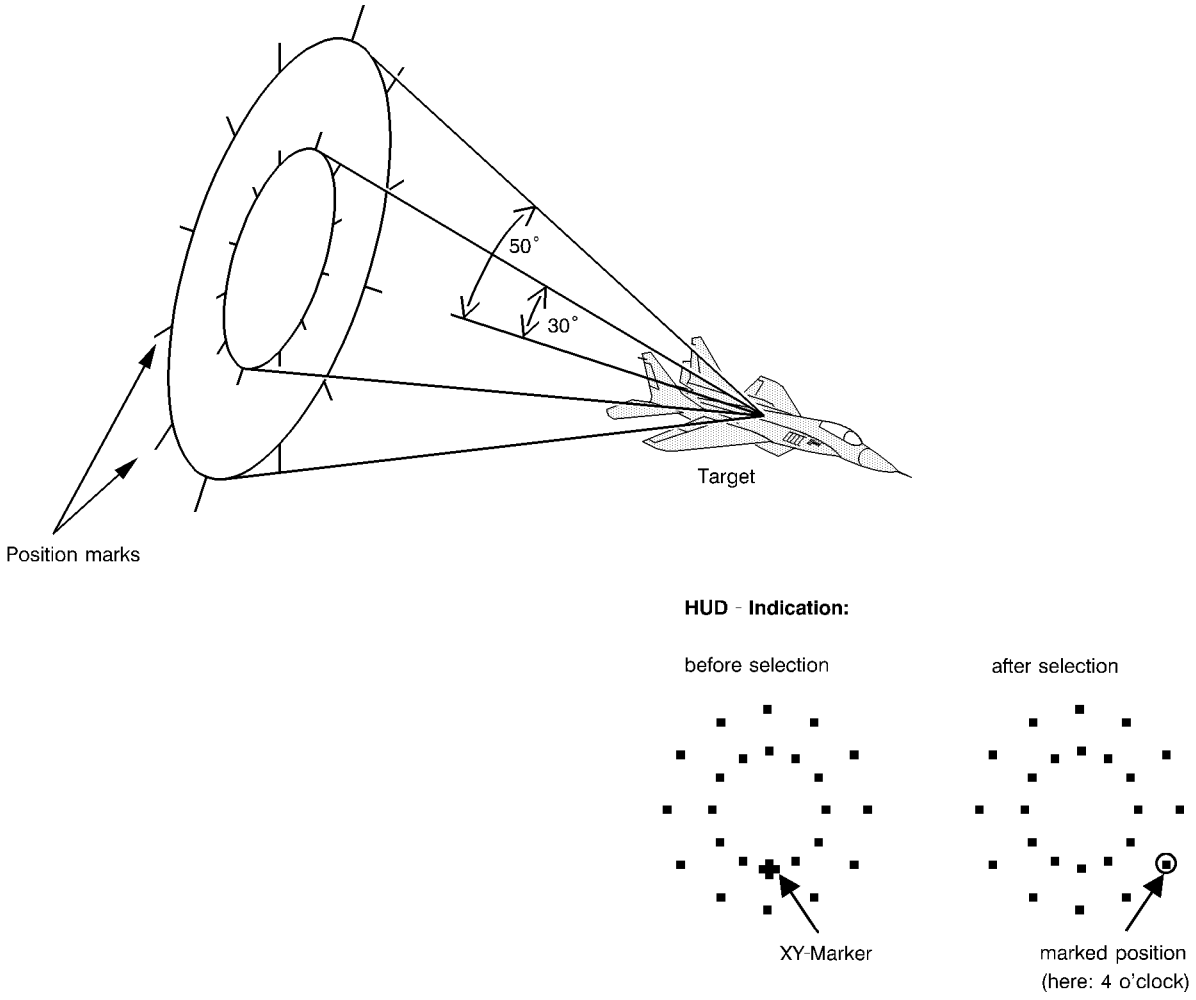


Figure 1.245 - VISident - Positions

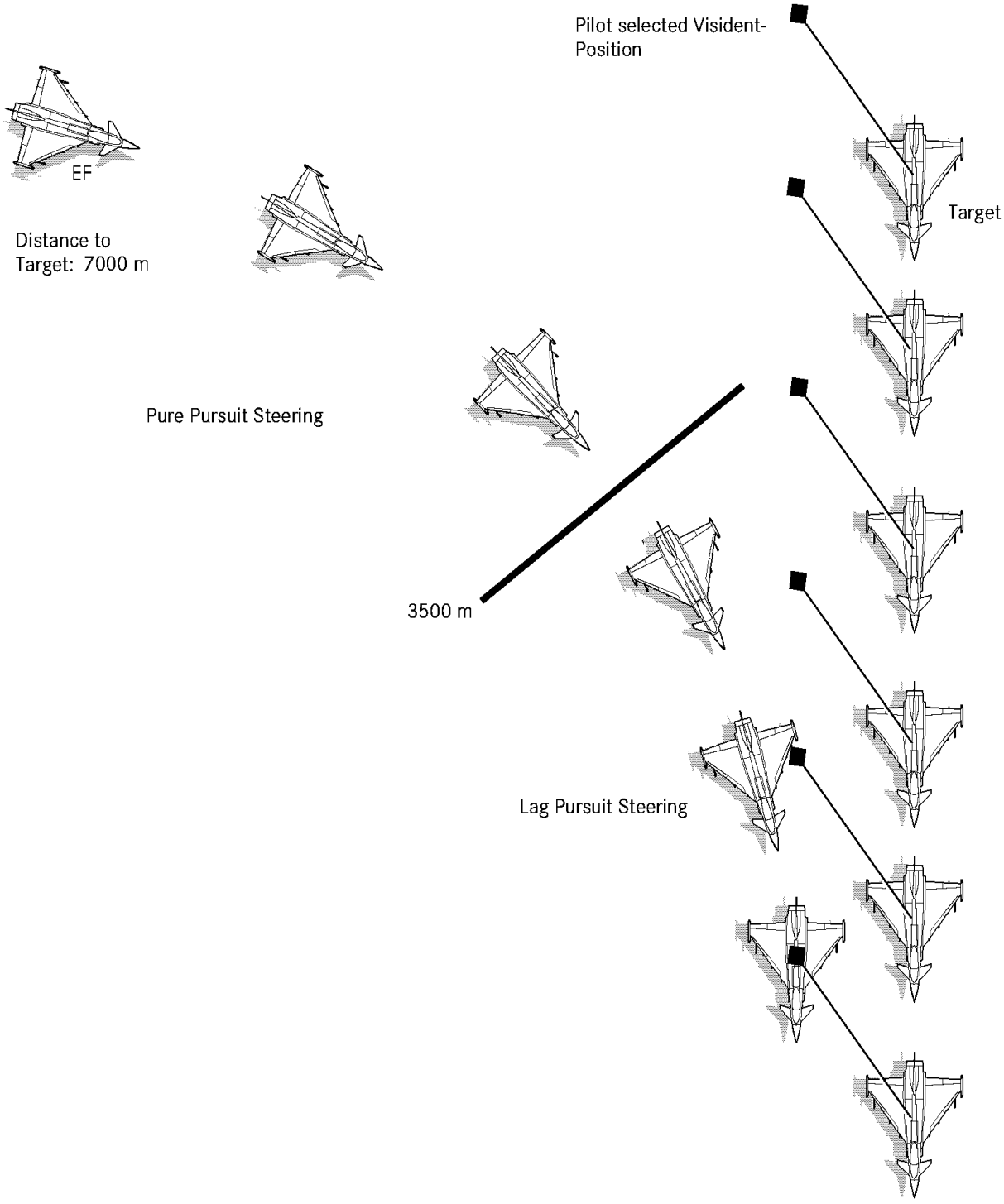


Figure 1.246 - VISident Steering

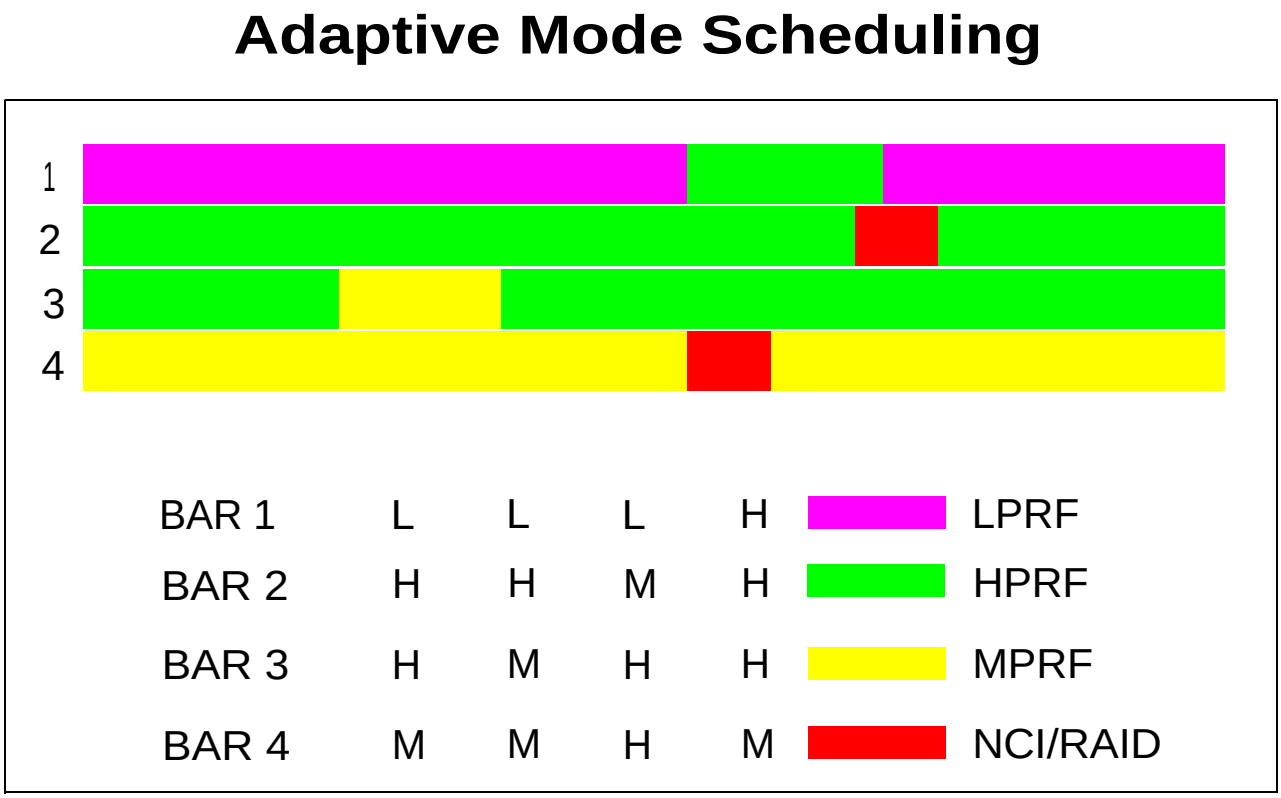
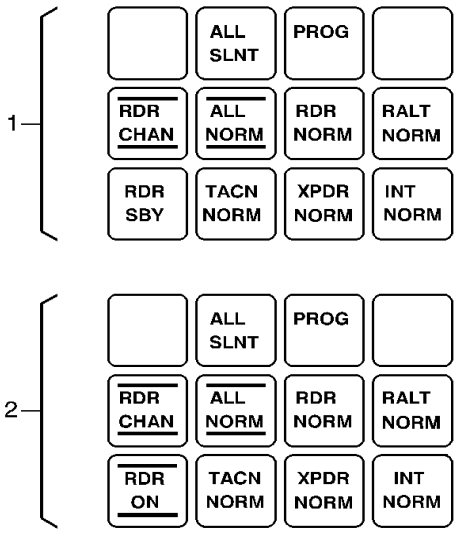


Figure 1.247 - Adaptive Waveform Scheduling (AWS)

Radar

(1B-B-93-10-00-00A-111B-A Issue 003)



1 DEFAULT SELECTION WITH RADAR POWER ON AND PBIT SATISFIED
2 RADAR OPERATIONAL MDE INDICATION

Figure 1.248 - Radar Mode Selection

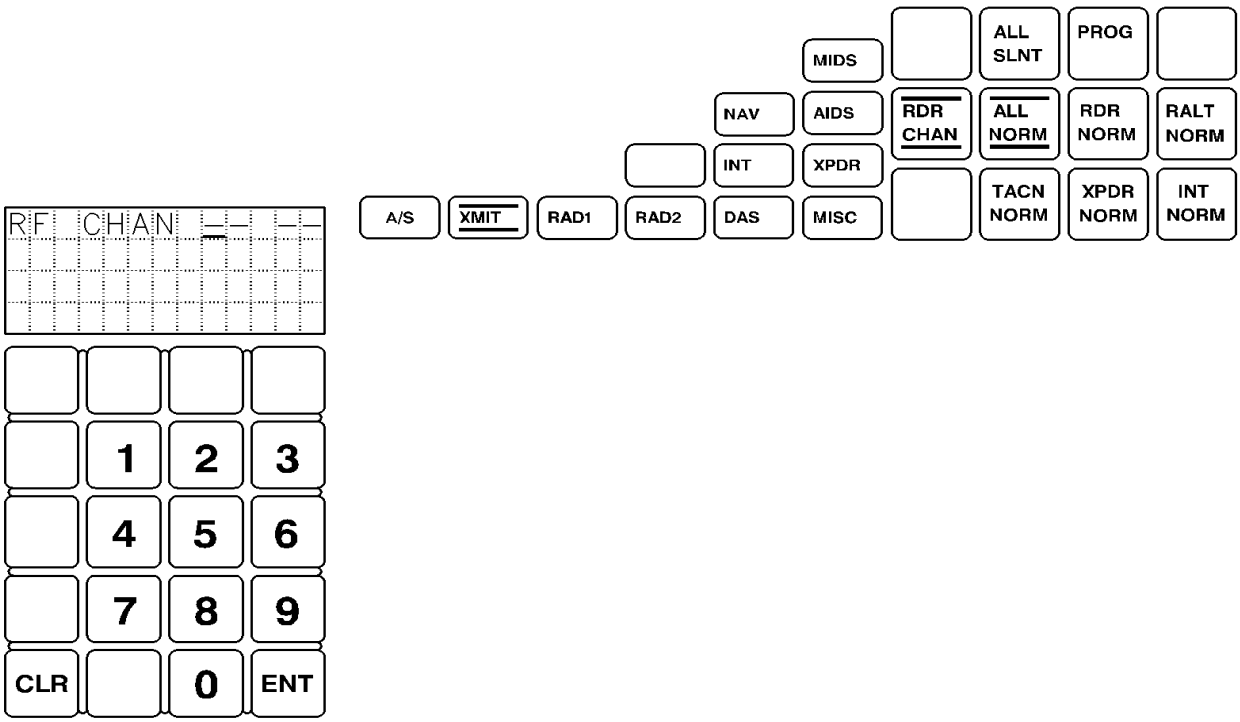
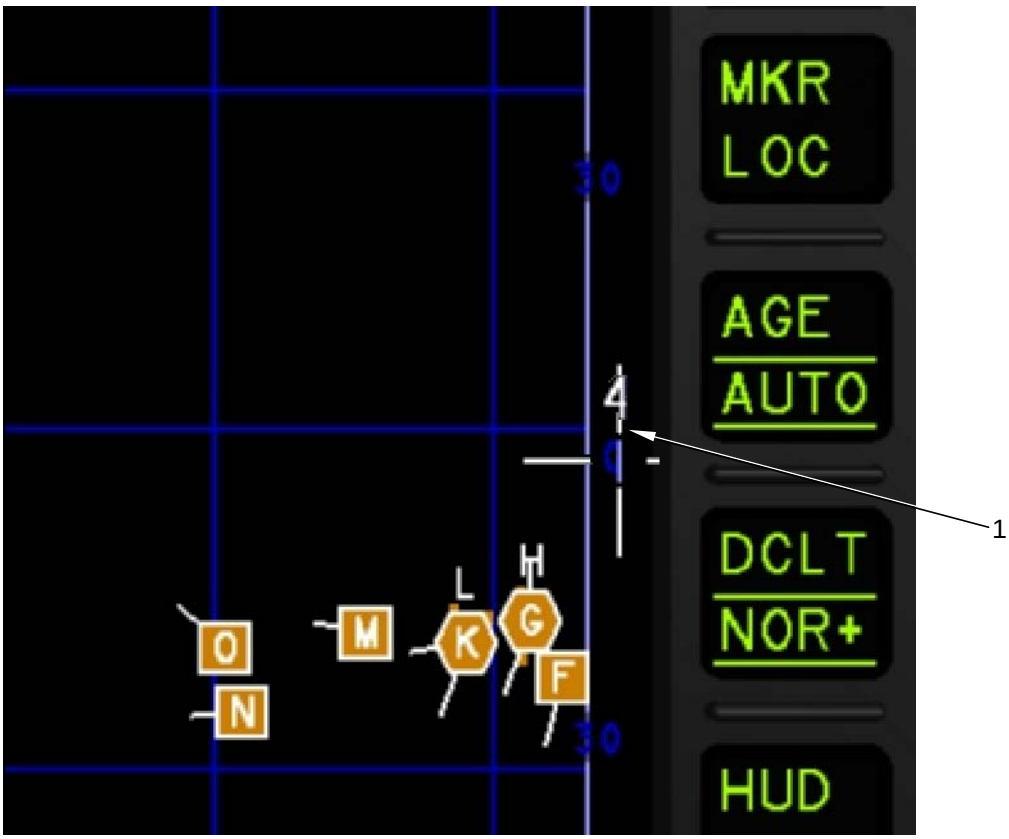


Figure 1.249 - XMIT Subsystem MDEF Default Configuration

1 TRACK IN MEMORY OUTSIDE RADAR SCAN AREA
2 X-Y MARKER POSITIONED FOR SCAN WIDTH ADJUSTMENT

Figure 1.250 - Attack Format PPI Display



1 X-Y MARKER POSITIONED FOR NUMBER OF SCAN BARS SELECTED

Figure 1.251 - Radar Scan Bar Adjust

1 RAID RANGE SCALE INDICATION
2 TRACK ALTITUDE
3 RANGE SCALE FROM WHICH RAID SELECTED
4 RAID POSITIONING CUE

Figure 1.252 - RAID Window

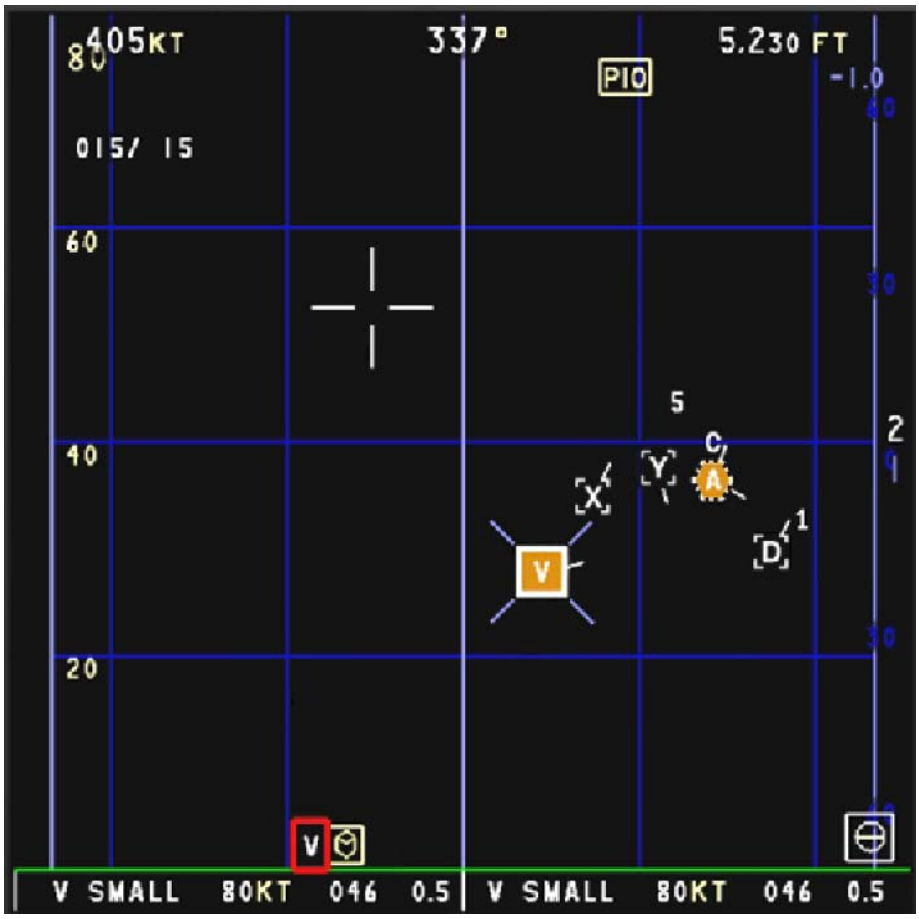
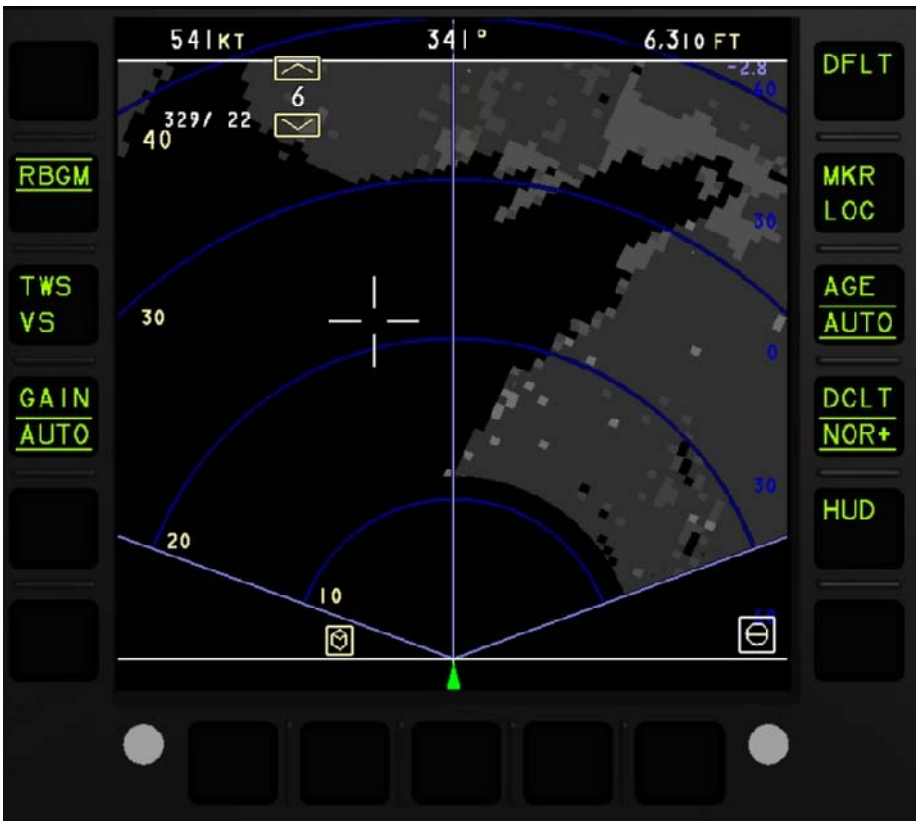
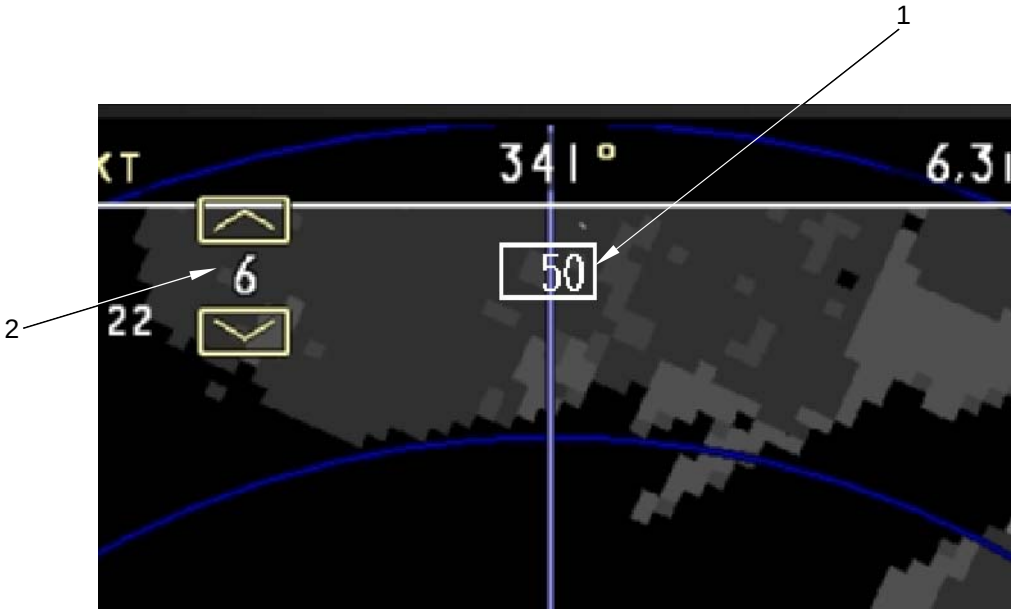


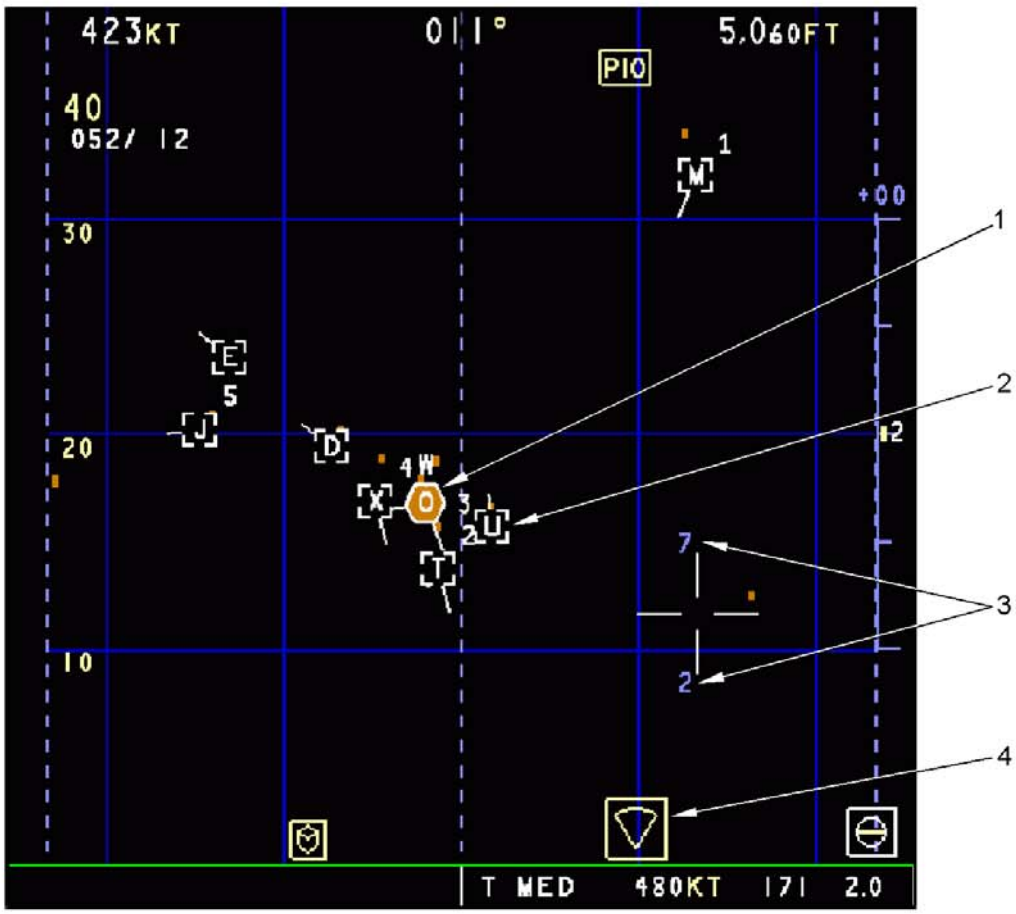
Figure 1.253 - Attack Format - Lock Follow





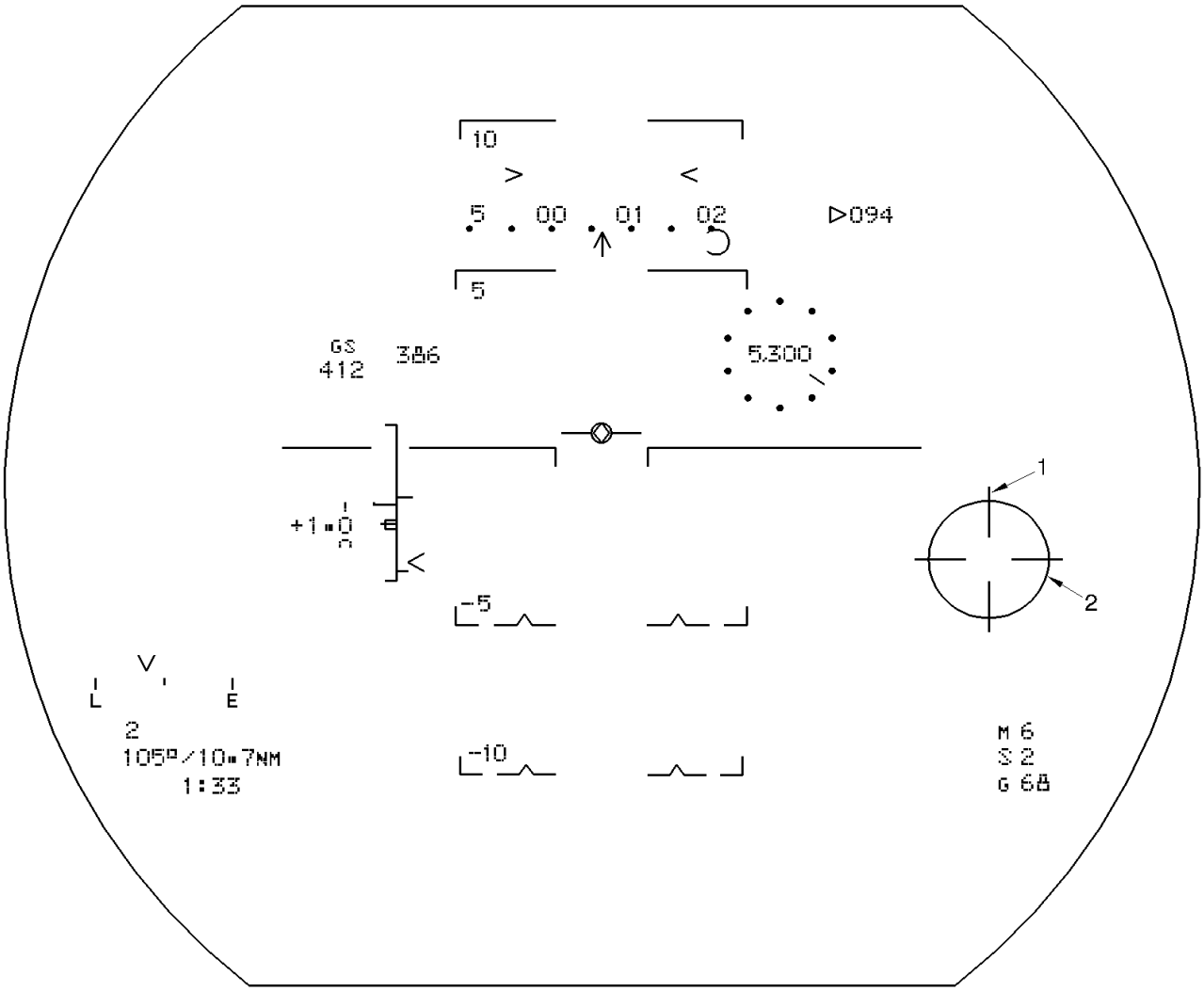
1 RBGM GAIN SETTING
2 RADAR ATTENUATION SETTING

Figure 1.254 - Attack Format - Real Beam Ground Mapping



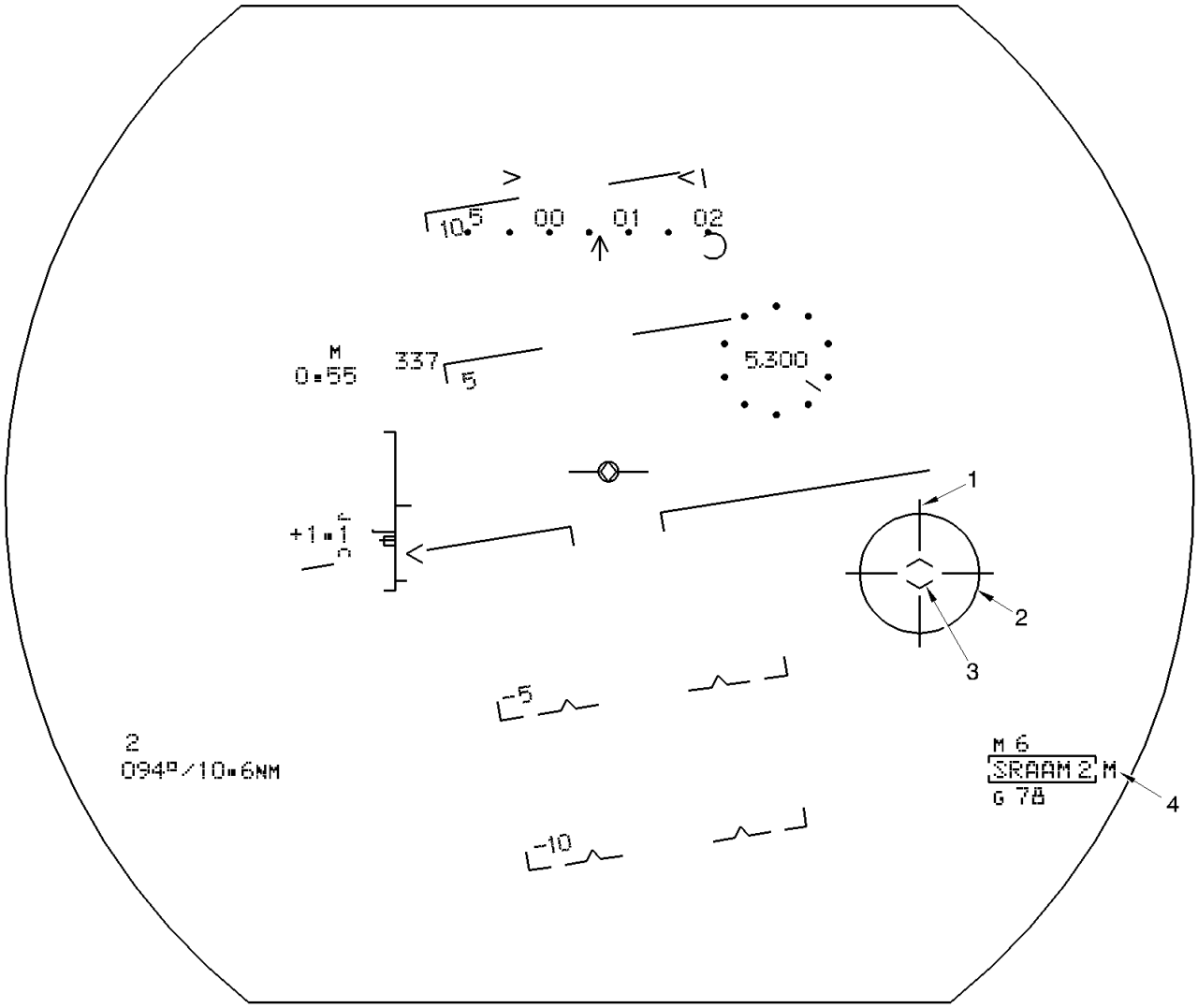
1 TGS
2 TRACK
3 RADAR ALTITUDE COVERAGE
4 ACTIVE SCAN ICON

Figure 1.255 - Attack Format - All Silent Mode



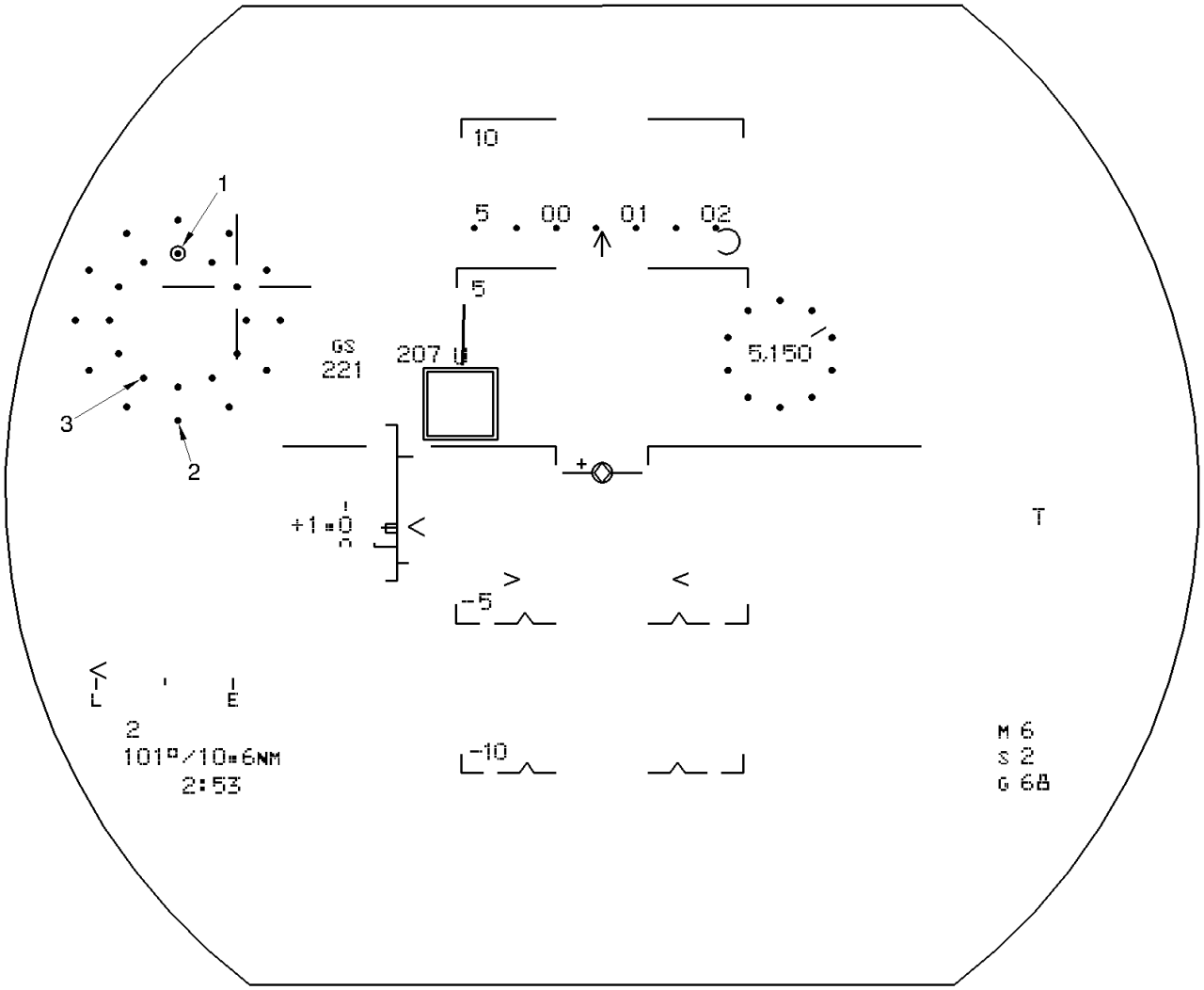
1 X - Y MARKER
2 RADAR SCAN COVERAGE

Figure 1.256 - HUD - Slaved Acquisition



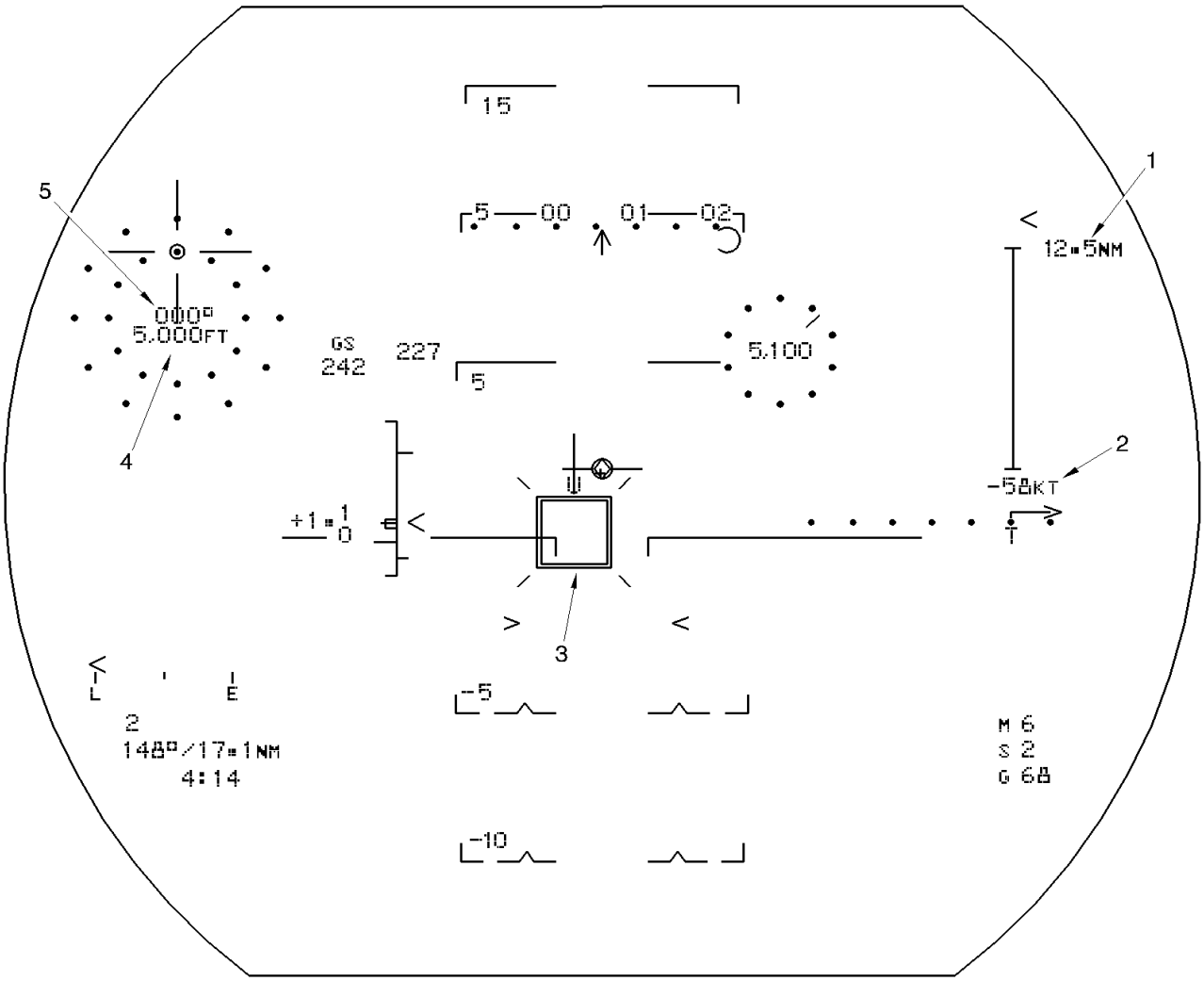
1 X - Y MARKER
2 RADAR SCAN COVERAGE
3 SRAAM SEEKER HEAD SYMBOL (NOT ACQUIRED)
4 SRAAM MANUAL MODE INDICATION

Figure 1.257 - HUD - Radar Slaved Acquisition and SRAAM Manual Mode



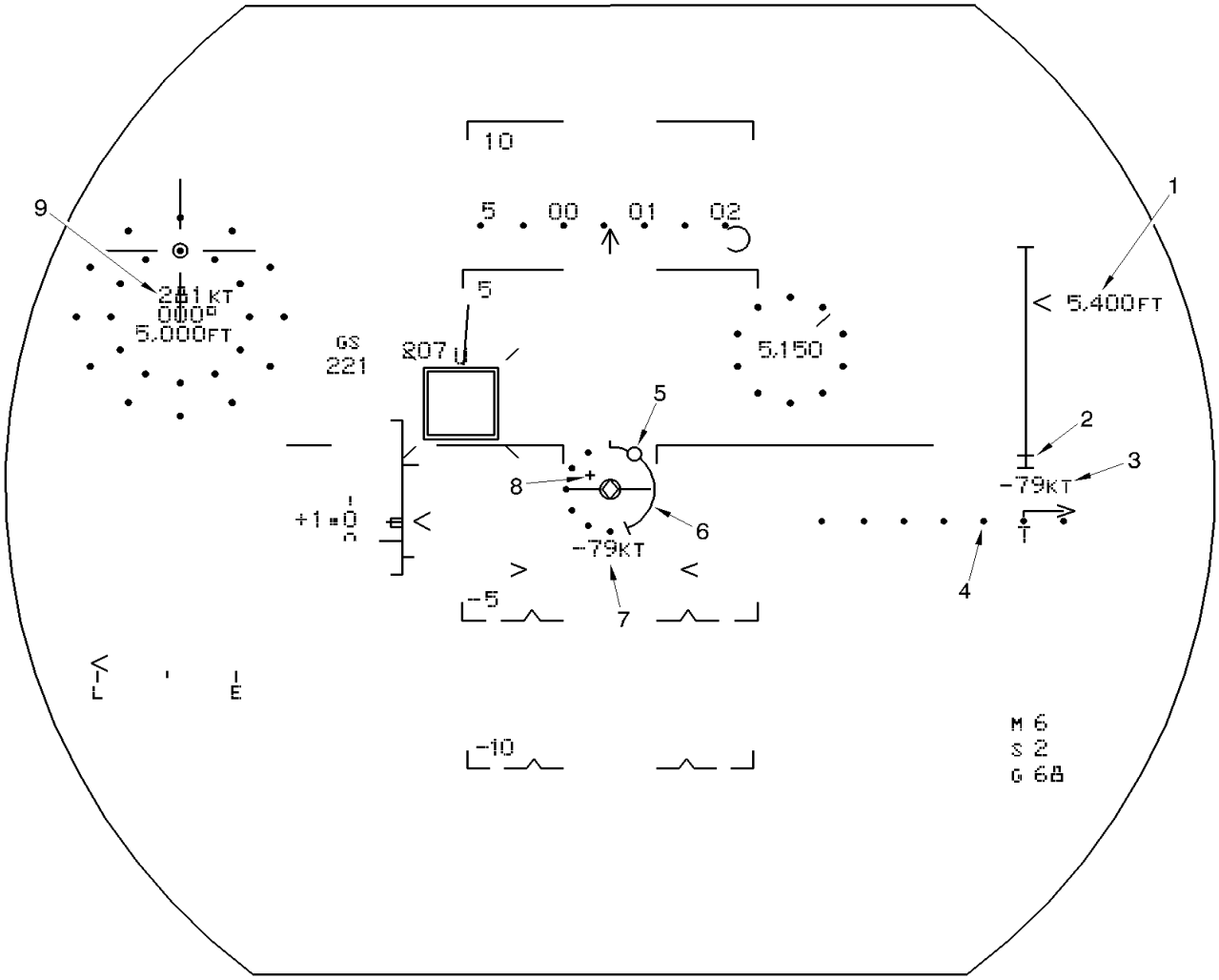
1 VISIDENT POSITION CUE MARKER
2 50° VISIDENT STEERING POSITION CONE
3 30° VISIDENT STEERING POSITION CONE

Figure 1.258 - HUD - Visident Position Select



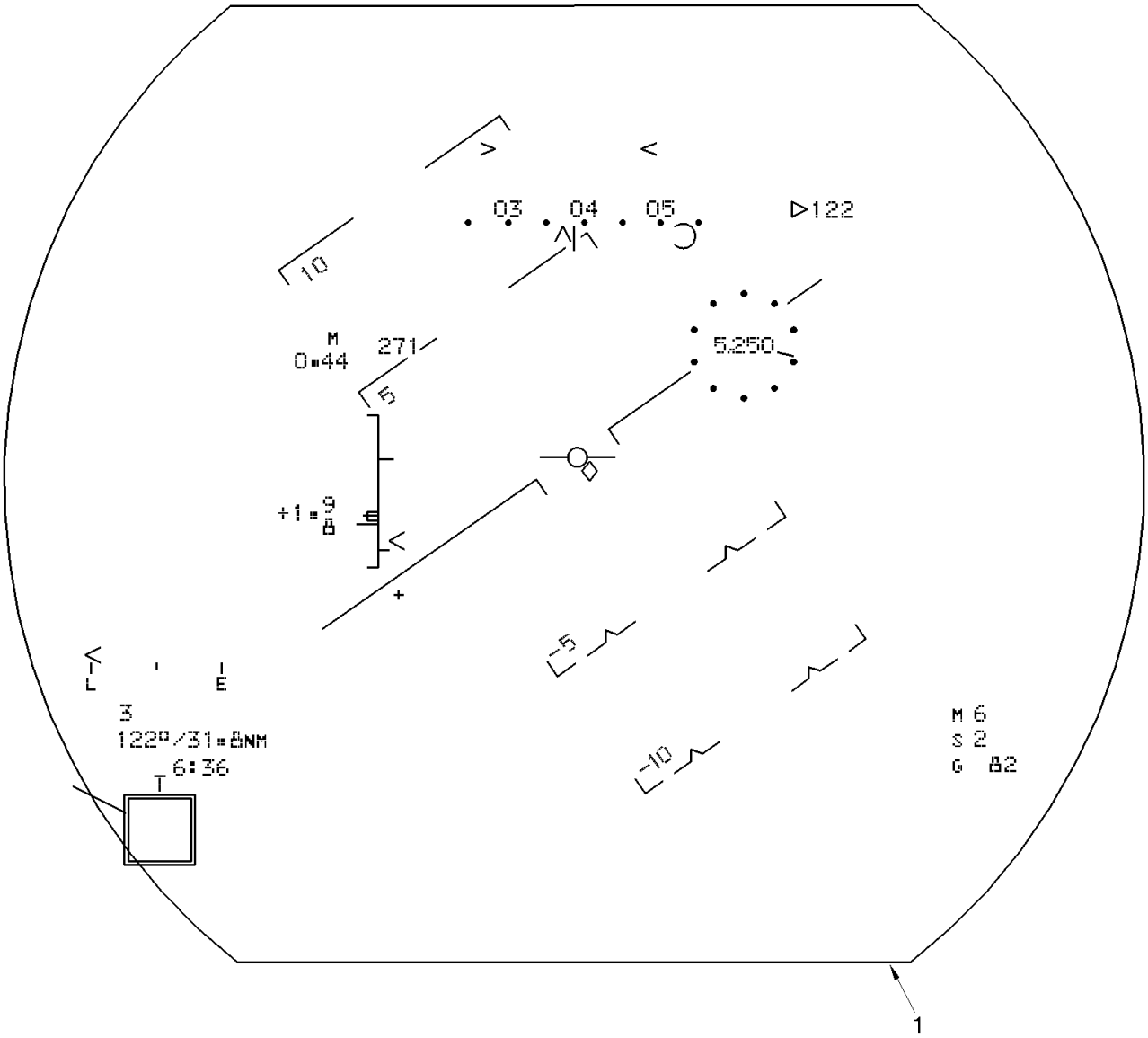
1 DISTANCE TO TARGET
2 CLOSING/OPENING SPEED
3 TD BOX - SIGHTLINE TO TARGET
4 TARGET ALTITUDE
5 TRACK OF TARGET

Figure 1.259 - HUD - Visident Radar Locked



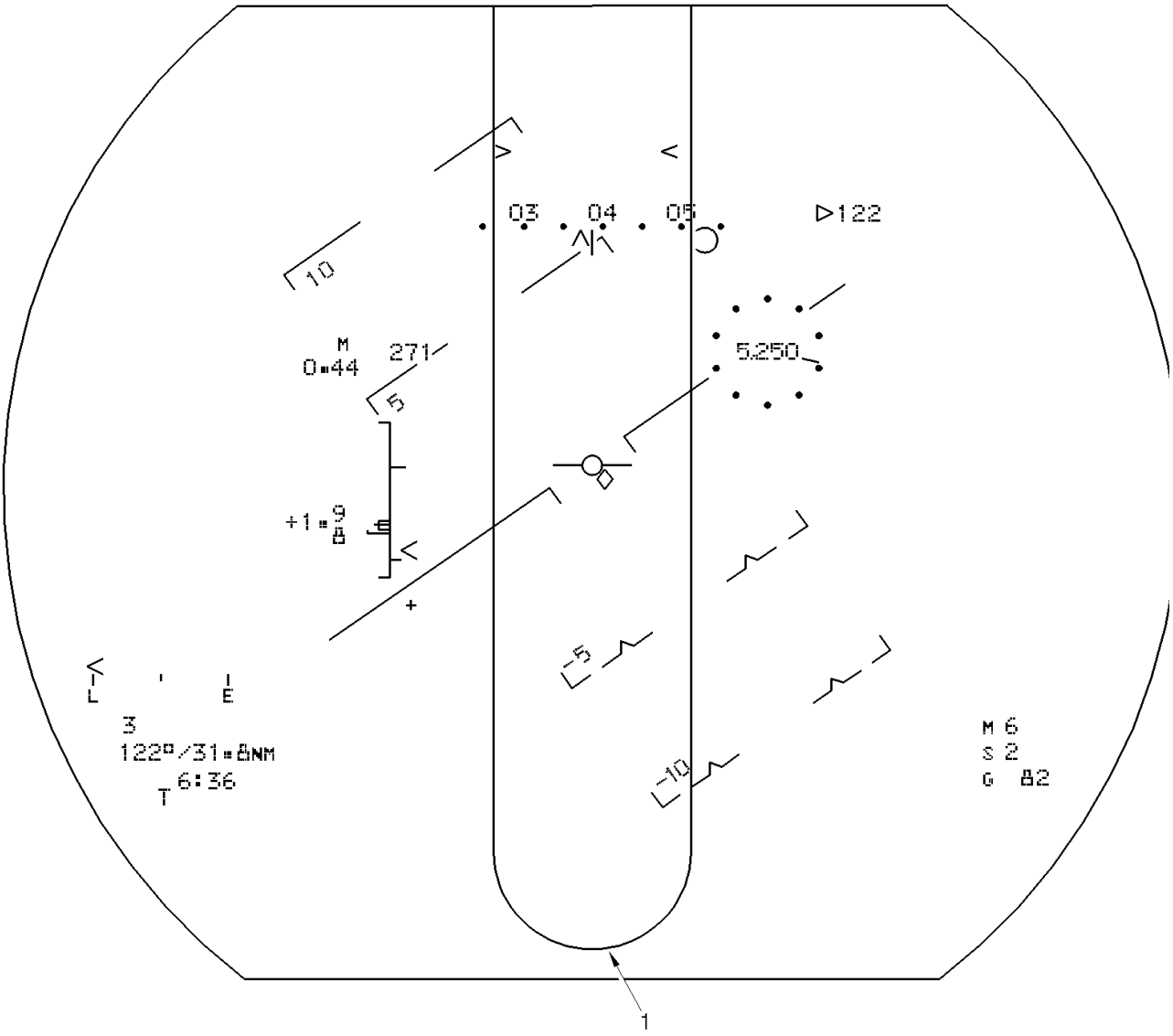
1 RANGE TO TARGET
2 MINIMUM VISIDENT RANGE MARKER
3 TARGET OPENING/CLOSING SPEED
4 VISIDENT CLOSING SPEED SCALE
5 MINIMUM VISIDENT RANGE
6 RANGE COUNTDOWN, EACH DOT EQUALS 1000FT
7 TARGET CLOSING/OPENING SPEED
8 STEERING DOT
9 TARGET AIRSPEED, TRACK, ALTITUDE

Figure 1.260 - HUD - Visident Target Within Maximum Range



1 AREA OF RADAR SCAN COVERAGE

Figure 1.261 - HUD Acquisition



1 AREA OF RADAR SCAN COVERAGE

NOTE...
EXTENDS BEYOND THE HUD FIELD OF VISION

Figure 1.262 - HUD - Vertical Acquisition

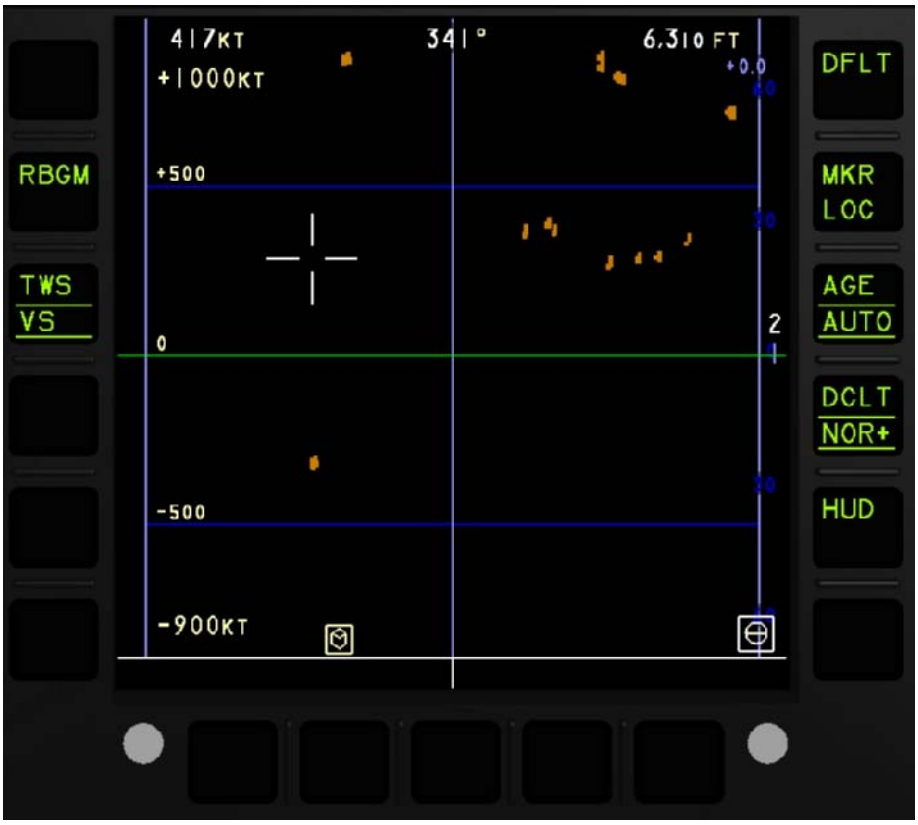
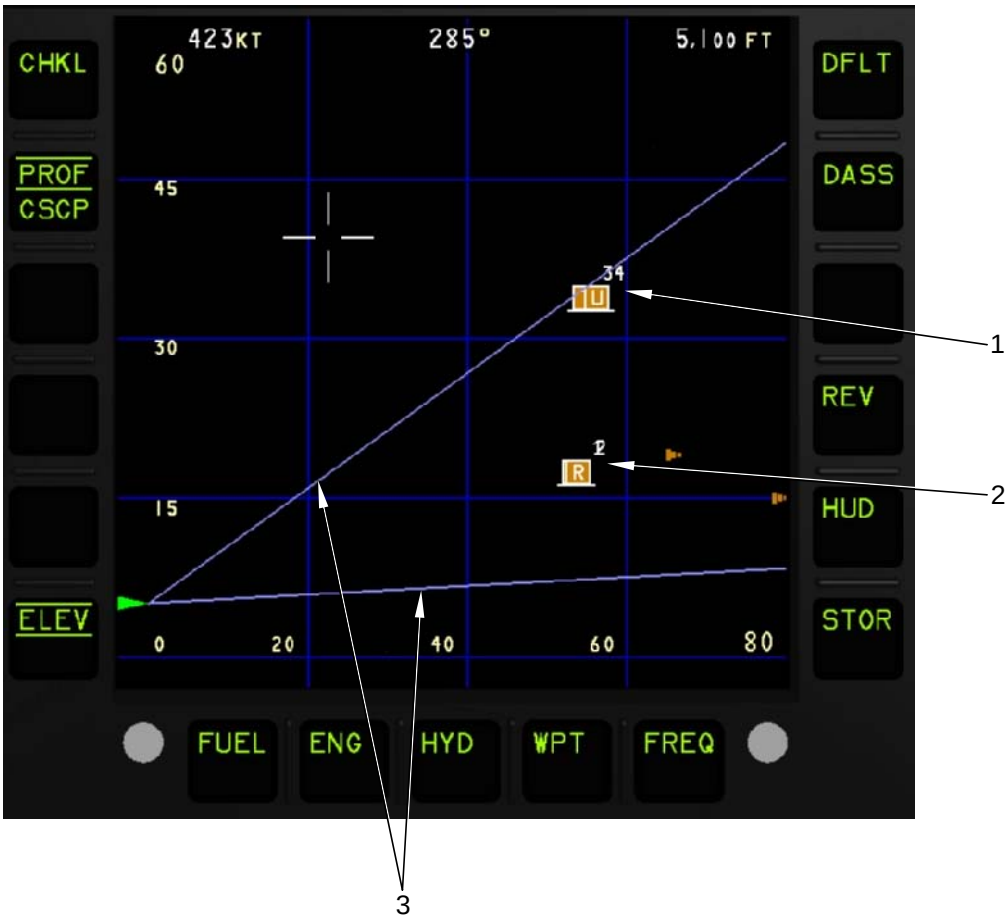


Figure 1.263 - Attack Format - Velocity Search



1 PRIORITY TRACKS 3 AND 4
2 PRIORITY TRACKS 1 AND 2
3 RADAR ELEVATION COVERAGE INDICATORS

Figure 1.264 - Elevation Format - Profile Display

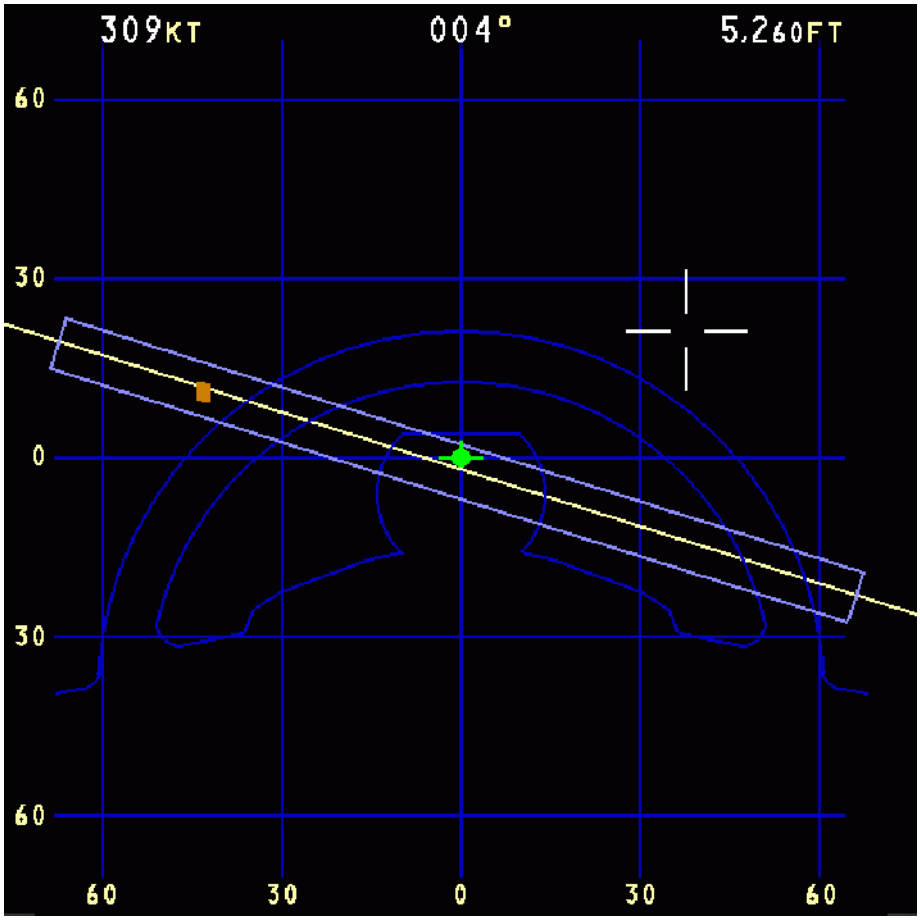


Figure 1.265 - Elevation Format - C scope with Outline Selected

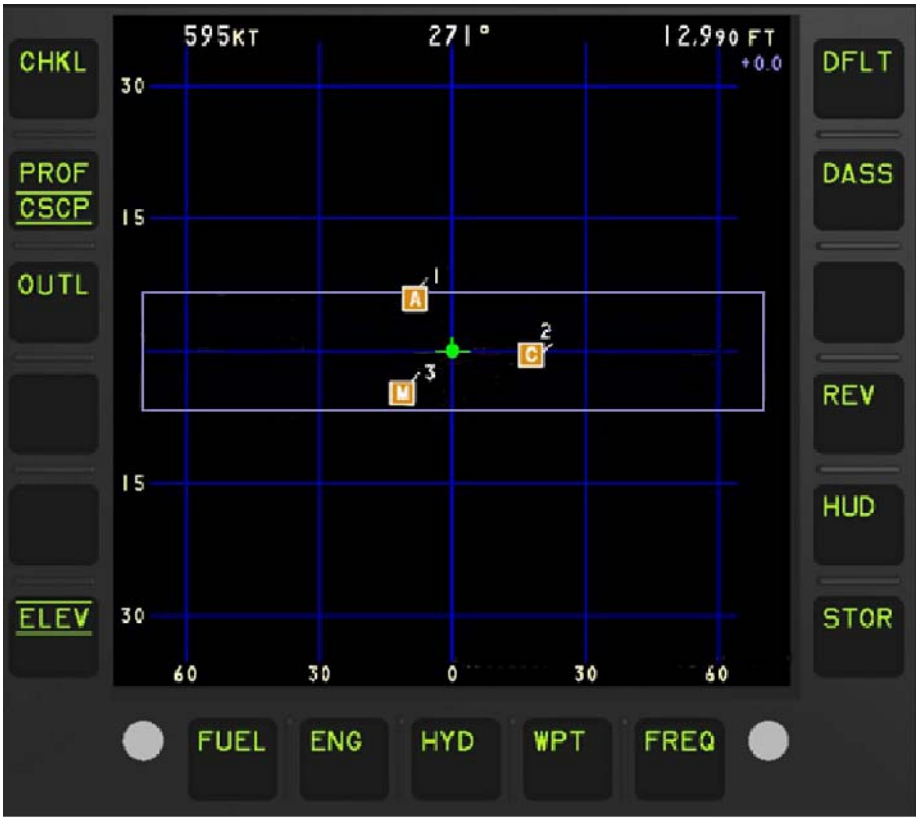
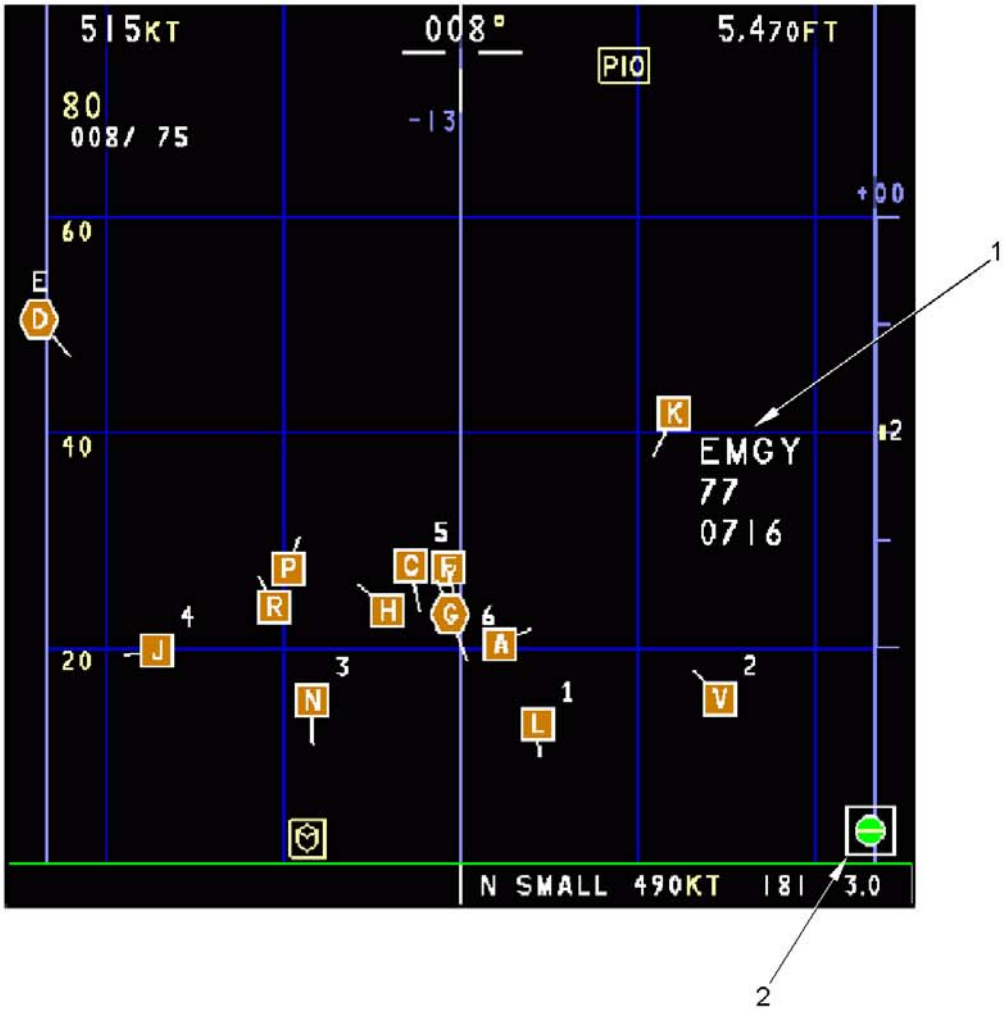


Figure 1.266 - Elevation Format - C scope



1 ACTIVE DECODE READOUT
2 TRANSPONDER MODE 4 RESPONSE ICON

Figure 1.267 - Attack Format IFF Indications

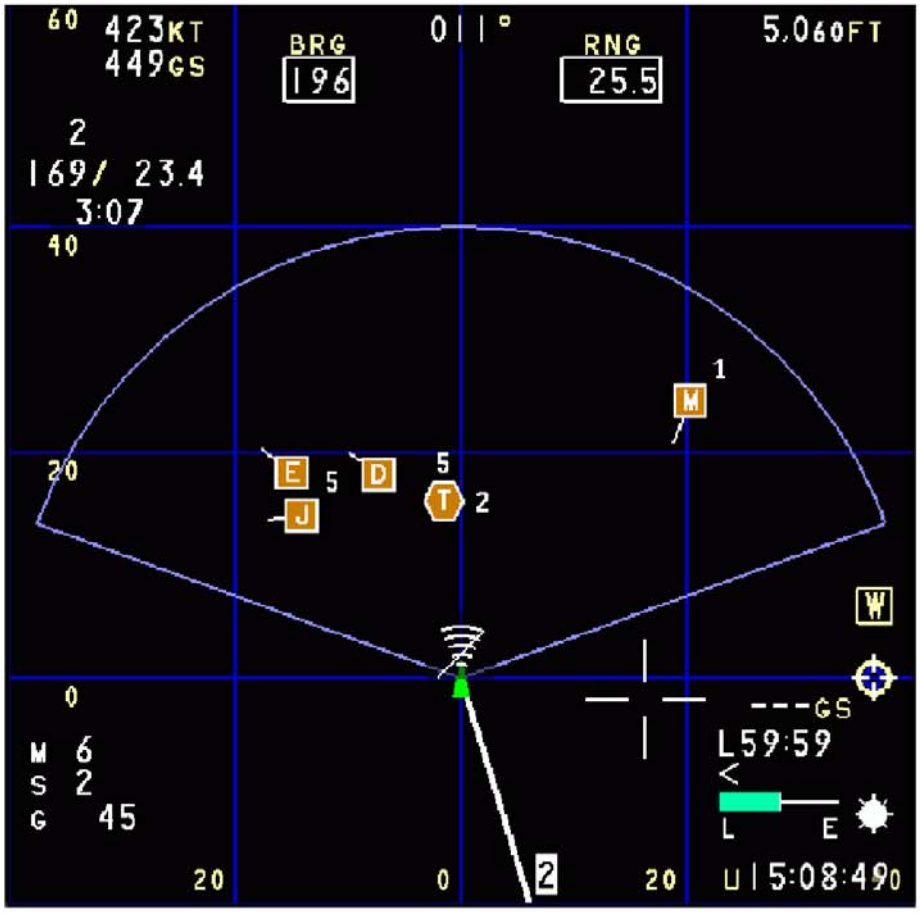


Figure 1.268 - PA Format - Program

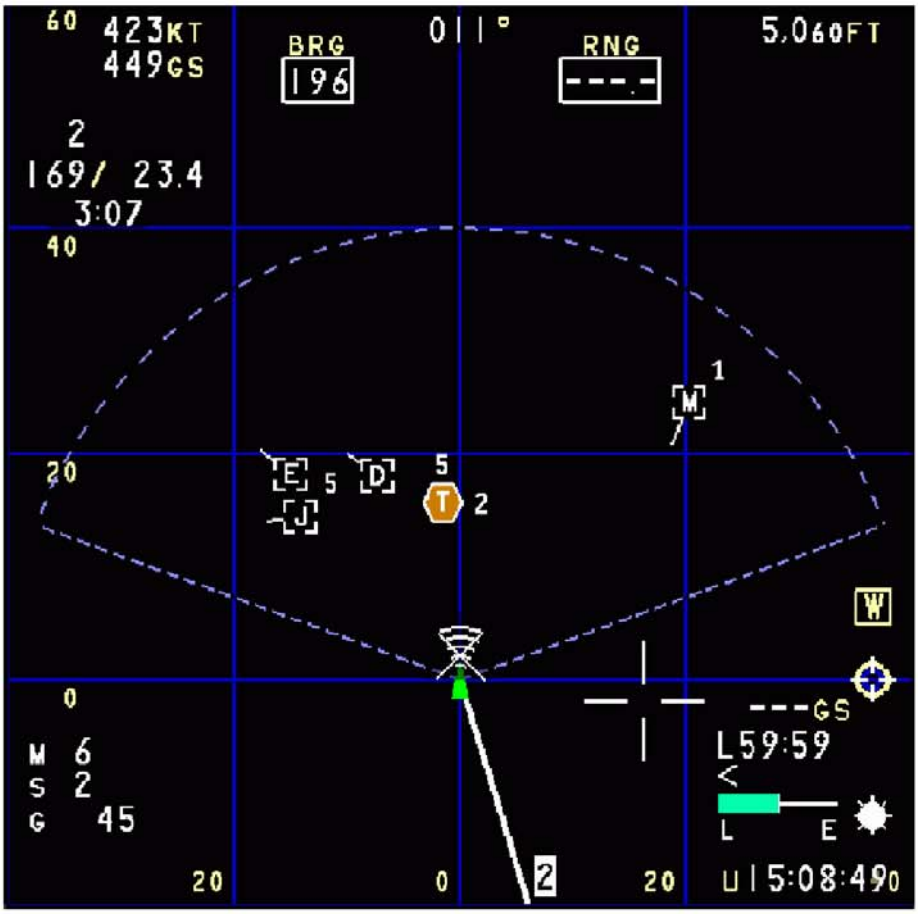


Figure 1.269 - PA Format - All Silent Mode

Radar

(1B-B-93-10-00-00A-111A-A Issue 006)

General

Moding and function control selections requiring pilot action is performed via:

- Radar switch on and switch off (hardwired)
- Radar Protective Interlock Override switch on left console
- MDE Subsystems Keys (SSK) and Moding Keys (MK) on the Left Glareshield (LGS).
- HOTAS radar control switches (Stick and Throttles):
  - Stick Controls (ACM modes, Radar Lock/ Break Lock)
  - Throttles Controls (Elevation Scan control, X-Y controller)
- SKs (located left, right and bottom of the MHDD formats)

Right Console - Gangbar RADAR/OFF switch

WARNING

TO ENHANCE RADIATION SAFETY, NO DESELECTION OF SBY OR SELECTION OF A RADAR TRANSMITTING MODE SHALL BE DONE WHILST ANY PERSONNEL ARE CLOSER THAN 55 METERS TO THE NOSE OF THE AIRCRAFT.

NOTE

- WHEN THE RADAR HAS BEEN SWITCHED OFF, IT IS RECOMMENDED TO APPLY A DELAY OF FIVE SECONDS BEFORE IT IS SWITCHED ON AGAIN. THIS IS COMMON PRACTICE FOR HIGH VOLTAGE HIGH POWER EQUIPMENT.

The radar is switched on during the start procedures by selecting the radar switch on the gangbar to RADAR. If system gangbar is not selected to on, a prompt will be given on the autocue format.
After switch on the radar will perform PBIT functions (100 sec.) and warm-up (3 minutes), refer to Figure 1.271. Transmit and receive operations are inhibited during warm-up on ground and in flight.
On completion of the PBIT:

- the “WARM UP” symbol is displayed on the AF (when selected),
- the radar modes are available for preselection on the AF, MDE and HOTAS
- on ground: the radar is defaulted to SBY (MK RDR SBY not boxed although in SBY), unless any radar mode preselection has been done. A preselected mode would be indicated (SK boxed) during warm-up. When preselecting a mode the RDR MK will change from RDR SBY to RDR ON. Pre-selections may be cancelled by selecting SBY again. In SBY no radar scan volumes are displayed on the MHDD formats.
- when airborne: the radar is defaulted to ON (MK RDR ON is boxed) and TWS (boxed automatically), unless any other radar mode preselection has been done. The radar scan volume is displayed dashed on the MHDD formats.

On completion of the warm-up the “WARM UP” symbol is occulted and the text string “RDR STBY” is shown.

On ground transmit and receive operations are inhibited by Weight on Wheel switch. At main wheel lift off the radar will automatically enter either the default mode TWS or any pre-selected mode and the moding key will change from RDR SBY to RDR ON.

Left Console - Radar Protective Interlock Override switch

The coverguarded, two position toggle switch labelled RADAR selects either the OVRD or NORM operating status. When selected to OVRD within 5 sec. after cooling fail the radar is forced to provide the active modes again until the radar total failure is reached. The override status (transmitting) will be inhibited with WOWs. OVRD can be deselected again by selecting the override switch back to NORM.

A prompt will be displayed on the Autocue Format when the RADAR Protective Interlock Override switch is selected to OVRD after power on.

Left Glareshield - MDEF

XMIT (SSK)

After power up the SSK XMIT is available for selection (Figure 1.270). The SSK XMIT will enable a set of Moding Keys (MK) described below to manage radar modes, channels and transmission inhibit, refer to Figure 1.274.

The DEK & ROL are configured for RDR CHAN input.

RDR SBY/RDR ON (MK)

The MK RDR SBY or RDR ON will be displayed when SSK XMIT is selected (Figure 1.276), provided the radar is powered up, i.e. switched on (gangbar RADAR) and PBIT cycle is completed. On ground the radar is defaulted to SBY, when no radar mode is preselected (note that no box is displayed with the MK RDR SBY). On preselecting a radar mode the RDR MK will automatically change from RDR SBY to RDR ON.

WARNING

TO ENHANCE RADIATION SAFETY, NO DESELECTION OF SBY OR SELECTION OF A RADAR TRANSMITTING MODE SHALL BE DONE WHILST ANY PERSONNEL ARE CLOSER THAN 55 METERS TO THE NOSE OF THE AIRCRAFT.

NOTE

If weight is on wheels, either left or right main landing gear, all radar emissions are inhibited. This inhibit function may be overridden by groundcrew for testing via the Weight on Wheels Override switch.

In SBY the scanner is parked at 6 deg up and 70 deg right and the transmitter and receiver is inhibited from functioning but remains warmed up. The radar scan lines will be occulted from the attack and elevation formats to indicate that the radar is not commanded to transmit. SBY selection is also indicated on the AF with the text string “RDR STBY”. The attack format radar mode indication is occulted. SBY can be selected during any phase of flight as long as PBIT has been completed.

NOTE

The SBY mode is automatically deselected on transition to Weight off Wheels and the moding key will change from RDR SBY to RDR ON. If required, the SBY mode must then be selected again.

When the radar is selected from RDR SBY to RDR ON, no warm-up period is required for fully active operation. The radar enters the previously selected A-A search mode. If there is no previous scanning mode to go (i.e. first selection after power up) the radar will enter the default TWS mode.

Transition time from SBY into an operational mode is 0.5 sec maximum.

RDR CHAN

Boxed by default. DEK & ROL are configured to enable one pair of radar channel numbers to be entered and the current channel pair is displayed on the ROL. When entered verify that the ROL's blink to show that the channels are acceptable, refer to Figure 1.275.

ALL NORM

Boxed by default, indicating that all transmitters are enabled for transmitting. The MKs for the individual transmitters are displayed for pre-selections of the program mode. This MKs are default to NORM when XMIT is pressed, but can be modified through a PDS load.

ALL SLNT

If selected, ALL SLNT is boxed, indicating that all transmitters are inhibited from transmitting.

PROG

If selected PROG is boxed; ALL NORM or ALL SLNT MK are deselected. Any of the system controls set to SLNT will be boxed, those set to NORM will not be boxed.

RDR NORM/SLNT

This individual transmitter MKs act as preselectors when PROG is not selected. The pre-selections for this individual transmitters are default to NORM when XMIT is pressed, but can be modified through a PDS load. When ALL NORM is selected (boxed) any selection of an individual transmitter key will preselect the relevant transmitter to either SLNT or NORM. The MK legend toggles between SLNT and NORM. The SLNT keys are only active when PROG is operated (boxed), for detailed Stealth Moding refer to Transmitter Management pag. 1-592.

HOTAS Controls and Functions

The following functions are selectable via the switches on the control stick and throttle.

Control Stick

On the control stick the following control is used for the radar:

Radar Air Combat Mode and Lock/Break Lock Selector

The RACM and Lock/Break Lock button enables selection of the Radar Air Combat Modes (RACM) or to initiate and break STT (refer to Figure 1.270).

A lock on can be achieved either automatically by an Air Combat Mode or manually.

To manually initiate a lock on, position the XY-marker over the plot, target or track and press the Lock/Break Lock button. No XY insert is required.

The search mode, from which the Lock Follow mode was selected, will remain indicated on the softkeys. This will indicate the radar mode which will be returned to when the lock is cancelled or lost.

Once the radar is locked to a plot/track, the maximum demandable volume is displayed on the attack and P.A. formats but the radar scan volume controls are occulted from the attack format excluding the range control.

The volume is occulted from the elevation format.

The elevation HOTAS control is disengaged.

The radar elevation centerline will be displayed on the attack format and the number of bars selected will be occulted.

The lock symbol is displayed on the attack, elevation, P.A. and HUD formats, indicating the track to which the radar is locked.

The sightline and range to the lock follow track is displayed on the HUD.

To break lock press the Lock/Break Lock button again. This cancels the lock even if the XY marker is not positioned over the locked track. The scan volume returns to the previously selected search volume, centered about the "break-lock" track, with the previously selected search scale displayed on the AF, PA and EF formats. The lock on can also be canceled by selecting a radar mode other than the lock on was initiated in.

Air Combat Mode selections are:

– FORWARD - Slaved/Boresight Acquisition (SACQ/BSTACQ)
– AFT - Vertical Acquisition (VACQ)
– RIGHT - HUD Field of View Acquisition (HUDACQ)

If the pilot wants to lock on to a different target whilst remaining in the current ACM mode, he can 'dump` the current radar lock and force the radar to search for another target to lock on by reselecting the current ACM.

The HUD formats associated with each of these modes are shown in Figure 1.273.

An ACM selection over-rides all other displays and radar selections on the ATCK format and the HUD.

Throttle Controls

Scanner Elevation/Gain Control Wheel

The throttle top assembly includes a control wheel for either manual control of the scanner elevation centerline or the radar gain in RBGM (refer to Figure 1.270).

An elevation coverage line will move up and down against the elevation scale on the right side of the AF to provide an indication of scanner elevation. A digital readout of the scanner elevation is also shown above the elevation scale. The elevation side scale indicates the maximum and minimum elevation scan limits with markers at 0 degrees, +/- 30 degrees and +/- 60 degrees.

A radar gain icon on the AF, selectable with the GAIN SK to MAN, allows toggling between the elevation or gain control modes with XY inserts and provides gain level indication. The control wheel is only live in VS, TWS and RBGM but movement in LF, STBY or ACM will be ignored. In ACM or LF the elevation is controlled automatically.

X-Y Controller

The X-Y controller on the front of the right throttle is used for the following radar control and display format functions:

– LF Manual Acquire (AF, PA and EF)
– Initiate Radar Tracks (AF, PA and EF)
– Deletion of tracks (AF)
– Denomination of targets (AF)
– Extra Data on tracks and targets (AF, PA and EF)
– Management of DTL (AF)
– Nomination of tracks as targets (AF, PA and EF)
– Reattack (AF)
– Bearing/Range Readout (AF)
– Azimuth scan volume adjustment (AF)
– Azimuth scan centerline adjustment (AF)
– Elevation bar scan selection (AF)
– Manual RAID selection (AF)
– Own Aircraft Speed (KDAS/MACH) selection (AF)
– Active Scan in Radar Inhibit selection (AF) (PSC 2.0 onwards)
– TGS Zoom function (AF and PA)
– Pilot Identity Override (PIO) (AF) (PSC 2.0 onwards)
– RBGM Gain selection (AF) (PSC 2.0 onwards)
– Radar Attenuation (AF) (PSC 2.0 onwards)
– Display Range scale changing (AF, PA, EF)
– Radar Altitude Coverage indication (AF, EF)
– SACQ sightline indication (HUD)
– SRAAM slave indication (HUD)
– VISident position selection (HUD)
– Altitude Scale Change (EF)

For detailed XY-controller operation refer to Radar pag. 1-500.

Own Aircraft Speed

XY insert over the own aircraft speed display changes the speed indication from KDAS to Mach number, and vice-versa on the AF. Whatever selection is made here also causes a consistent change to the speed indication for tracks and targets shown in the ROLs, except that in the ROLs, true airspeed is displayed rather than airspeed.

MHDD Formats

Attack and Identification relevant information is available on the following MHDD formats:

– MHDD/ATCK-TWS format
– MHDD/ATCK-VS format
– MHDD/ELEV format
– MHDD/PA format
– MHDD/DASS format
– MHDD/ACUE format
– MHDD/HDHUD format

For head down display operation, a Climb/Dive Ball may be displayed on the AF and EF. The C/D Ball is selected with the SK “C/D BALL” on the PA Format. The following information will be presented with the C/D Ball:

– Steering dot
– Turnaway limits for MRAAM inflight
– Allowable Steering Error (MRAAM, AIM-9L)
– Climb/dive and bank angles
– Horizon line with blue sky above and brown earth below
– Aircraft symbol

Attack Format (ATCK)

The MHDD/ATCK format provides the primary display and feedback to the pilot for sensor control, attack conversion cueing, and weapon launch cueing.
The MHDD/ATCK format is automatically displayed by default on the LMHDD in T/O, NAV, CMBT and APP/LDG POFs.
When the radar is switched on and PBIT is completed, “WARM UP” will be displayed on the AF until warm up is completed.
“Radar Standby”, is indicated on the AF above the ROL, when the radar is selected to SBY, detects any internal problem or problems with data from the weapon system.
The following SKs are available:

MHDD/ATCK Format SKs

SK LABEL	SELECTED MODE IS BOXED
PPI	When pressed selects PPI format from B-Scope format (default unless PSMK defined).
B-SP	B-Scope presentation is the default format in TWS, unless PSMK defined.
RBGM	Selects Real Beam Ground Mapping.
TWS	Default mode of the radar.
VS	Selects velocity search mode.
GAIN	Selects between either automatic (default) or manual gain control when in RBGM (PSC 2.0 onwards).
AUTO or MAN	
SCAN	Selects between automatic (AUTO) and manual (MAN) center line positioning in TWS.
AUTO or MAN	
NTCH	Selects between notch filter “AUTO” or “LOW”, SK not available when radar in: OFF, SBY, PBIT, VS, LF, or any A/S modes.
AUTO or	Automatic operation will be with larger notch when looking down (to reduce ground clutter) and a smaller notch when looking up.
LOW	Allows the radar to detect low speed tracks when looking down, i.e. helicopters, but with increased clutter (boxed when selected).
ACUE	Selects the Autocue format. Upon selection the SK remodes to enable return to Attack format. Available with weight on wheels and until landing gear up is selected.
UNDO	Rapid denomination of all targets
VIS	Selects/deselects VISident mode against a designated track. (Warning: Do not relay on radar derived information for safe separation)

SK LABEL	SELECTED MODE IS BOXED
SRCH	Selects between the following search priority modes:
AWS or	Adaptive Waveform Scheduling (default)
PS or	Priority Search
NORM	Normal Mode (no AWS or PS)
DFLT	Enables to set the format back to its default values.
MKR	Sets the Marker next to this SK.
LOC	
AGE	Selects plot ageing time in sec. (AUTO, 15, 10 or 5 sec). Default setting is AUTO.
AUTO, 15, 10. or 5	An Automatic plot aging time will equal to 2.5 times the scan volume time, enabling 2 or 3 plots to be displayed for each detected object.
DCLT	Selects between three declutter levels, Normal (NOR), Maximum (MAX) and Minimum (MIN) on the head down displays. “+” or “-” indicates that the next press will select either MAX or MIN declutter.
MAX or	
NOR+/ NOR- or	
MIN	
HUD	Selects the MHDD HUD display.
XFOV	Selects/deselects AIM-9L to wider field of view scan pattern (only shown when AIM9-L selected).

Elevation Format (ELEV)

Radar plots and tracks are also shown on the MHDD/ELEV format, which can be selected to present either a profile or a C-Scope format. The profile format is a range/elevation format on which radar data is presented at true slant range and elevation from aircraft position. C-Scope is an elevation/azimuth display with a selectable canopy outline image. The profile or the C-Scope format is selectable by the SK PROF/CSCP. On selection of the ELEV format PROF will be default (boxed).

The MHDD/ELEV format is automatically displayed by default on the right MHDD in NAV and A/A CMBT POFs. The ELEV format can also be selected from

the MHDD/formats HYD, FUEL, WPT and FREQ by use of the ELEV SK.

The PROF default settings are the range scale set to the same as on the ATCK, and the height scale set to 60 000 ft (PSMK definable). The height scale is adjustable by bumping the XY cursor at the top and bottom of the display. The heights displayed are 0-10 000 ft, 0-20 000 ft, 0-40 000 ft, 0-60 000 ft or 0-1000 000 ft. Own aircraft height is shown by a green triangle on the left side. Only height scales which include own aircraft height are selectable, e.g. if flying in 50 000 ft only 0-60 000 ft or 0-100 000 ft scales are available. If PP reaches the top of the current scale then the height scale will automatically change to the next height. The radar profile scan coverage will be displayed with light blue lines (dashed when inhibited).

The CSCP is an azimuth versus elevation display. It may be selected manually from the SK available in PROF format, or automatically on entry into full VISident mode or if Velocity Search mode is selected on the ATCK format. To allow easier transition to short range combat a canopy outline and horizon line is selectable via the SK OUTL. These will be aircraft axis stabilized and tracks/targets are referenced to the horizon. The radar azimuth and elevation scan coverage will be displayed as a light blue sector (dashed when inhibited). Track and target symbology is identical to that shown on the ATCK and PA format, except that the velocity vector proboscis is drawn only vertical up or down, to indicate a climb or descent rate greater than 2000 ft/min. TGS symbology is not used.

NOTE

In VS mode this is the only elevation format available.

Pilot Awareness Format (PA)

The PA format is designed to assist the pilot in developing situation awareness by providing a single display relating all relevant target and tactical data to his geographic position. Tracks, navigational routes and tactical overlays are shown.

The MHDD/PA format is automatically presented by default on the CMHDD in all POF.

Tracks symbology is identical to that shown on the ATCK format, except that TGS symbols do not show the component velocity vectors and the TCRIs of the tracks other than the top component track are not displayed: instead a total number of tracks within the TGS is shown by a number above the TGS.

The radar scan coverage symbology is identical to that shown on the ATCK format (PPI), except that it is displayed with an additional max. range arc. When the radar is selected to VS mode, the arc will displayed dashed to indicate the previous max. range of the radar in azimuth.

DASS Format

The DASS format displays radar and IRST scan coverage (PSC 3.0 onwards) in both axes. The azimuth coverage is shown as arcs based on screen center, while elevation coverage is shown as white (IRST) and light blue (Radar) bars adjacent to the elevation scale.

Autocue Format

The following prompts are displayed for the radar system during ground operation:

– “RADAR OVRD” when the RADAR NORM/OVRD switch is selected to OVRD after power on.
– “SYSTEMS GANGBAR” when the radar is off after engine start.
– “PDS ERROR A+I DATA” when a PDS Attack and Identification Data loading error occurs.

Track-While-Scan (TWS)

On takeoff with weight-off-wheels the radar will automatically enter TWS, if no other mode has been pre-selected on the ground. In flight if SBY has been selected, on de-selection of the SBY mode the radar will enter the last scanning mode that was selected. If no previous scanning mode exists the radar will enter TWS mode.

The scan volume remains the same as the volume for the mode from which TWS was selected, (or default if no previous selection was made), unless manually adjusted.

If this was VS then the display range will be the last selected range.

If this was Lock Follow then the volume will be the previous search volume and range, with the centroid positioned about the position of the Lock Follow track.

If this was an ACM the volume will be the last selected search volume.

If this was RBGM then the volume will remain the same.

When the XY marker is displayed on the A.F. within the radar scan volume a readout of the radar altitude coverage, at the range of the marker, will be displayed with the marker. The light blue digits indicate whole thousands of feet and show negative values when radar intercepts the ground.

TWS B-Scope

TWS B-Scope is a range/azimuth presentation of radar contacts, where range is represented along a vertical scale and azimuth along the horizontal scale. The horizontal scale is marked at 0°, 30° and 60° left

and right of centerline (max horizontal scale is 70° either side). The two scales are combined to form a range/azimuth grid (displayed in blue) against which the position of radar contacts are shown (depending on which range scale is selected). Current radar elevation coverage is indicated by the elevation coverage line positioned against the elevation side scale. The length of the line is dependent upon the elevation coverage provided by the current bar scan pattern.

B-Scope is default, unless PPI is PSMK defined.

Deselection of RBGM (PPI only) by selection of a radar A/A mode will automatically default back to B-Scope if B-Scope was the previously selected radar A/A display.

TWS PPI-Scope

TWS PPI-Scope or Plan Position Indicator is a range/range presentation selectable by the pilot on the MHDD/ATCK format. It presents all data relevant to own aircraft position.

Velocity Search Format (VS)

The vertical scale represents the target's contribution to the closing velocity. The bottom of the scale represents -900 KT (opening) and the top of the scale represents either +4500 KT (default) or +1000 KT (closing), depending upon which scale is selected. Own aircraft velocity is shown by the green line at zero range rate.

NOTE

The radar can not detect targets with opening velocities or targets within the clutter notch region.

The horizontal scale is marked with blue grid lines at 0°, 30° and 60° left and right of centerline (max horizontal scale is 70° either side).

The velocity scales are increased or decreased by "bumping" the XY cursor on the top or bottom of the display respectively.

The grid lines on the vertical scale represent a quarter increment of the selected scale (+4500, +3000, +2000, +1000, 0, -900 or +1000, +500, 0, -500). The two scales are combined to form a velocity/azimuth grid (displayed in blue) against which radar symbols are read according to the formerly selected velocity scale.

During operation in VS, radar contacts will only be displayed as radar plots (amber rectangles). If subsequent radar scans fail to update the plot, the plot will occult.

Radar tracks cannot be initiated in VS mode although the relevant plot will be promoted to track status if a lock-on was successful. If Lock Follow is achieved on a VS plot then the display will change to the default range format. The scan volume remains the same as the volume for the mode from which VS was selected. If the mode from which VS was selected was Lock Follows then the volume is set to the previous scan width, and number of bars from the last selected search mode selected, centered about the Lock Follow track position.

The velocity coverage will be the default coverage, for the first selection of this mode, or the previously selected value of this parameter will be used.

The display velocity scale will be the last selected, if no pre-selection is made then this will be the full velocity coverage display.

The profile option is not available in this mode, therefore a c-scope elevation format will be displayed.

The SRCH PS softkey is occulted.

On the P.A. format the scan volume range limit is displayed as a dashed line at the range selected in the previous mode, e.g. TWS.

Display Scale Control

Display Range (AF, EF, PA)

The display range is selected:

- manually using the XY controller or
- is automated in TWS with ASC selected and a target nominated or
- is automated in Lock Follow mode in relation to the ranges of the nominated targets.

The range scales are increased or decreased by "bumping" the XY cursor on the top or bottom of the display respectively with a change rate of two steps a second.

The range presently selected is indicated on the AF as 4, 10 20, 40, 80, 160 or 240 NM (240 not for RBGM).

Auto changing of displayed range will occur when all nominated targets close to within 75% of the next lower range scale but not below 10 NM. When any nominated target opens to 85% of the current display range it will auto change to the next highest scale.

It is still possible to manually change the display range scale.

During STT, automatic range scale adjustment is enabled, however, range scale options are still available.

The range grids will be adjusted on the AF and EF profile format accordingly to indicate the new range selection.

The radar scan volume will be adjusted on the PA format accordingly to indicate the new range selection.

Display Velocity Scale (VS)

In VS mode the velocity scale can be altered from + 4500 kt to - 900 kt and + 1000 kt to - 900 kt using the XY controller. The own aircraft velocity will be indicated at the zero velocity line.

NOTE

The VS mode does not include range, therefore the only elevation format applicable to this mode will be the c-scope format.

Display Height (EF)

The height scale can be selected by "bumping" the XY cursor on the top or bottom of the display, and is limited to a scale which includes own aircraft.
Changing the display altitude coverage has no effect on the radar scan volume, i.e. this is purely a display function.
The default height for this format is 60,000 feet and the range is equivalent to the AF range. The Normal softkey selects the default format for the appropriate POF at its default settings.
This function is not available on the Elevation C-Scope Format.

Display Elevation Coverage (C-Scope)

The elevation c-scope format is an azimuth versus elevation display. This format can be selected manually via the elevation format or automatically when VISident is entered. The elevation coverage of this format is controlled by the range selected on the attack format, refer to Table , “C-Scope Auto Range/ Elevation Coverage,” on page 1-530, or by selection of the canopy outline.
When canopy outline is selected a canopy outline image with the horizon line is displayed on the C-scope referenced to airframe for easier transition to short range combat. In all other cases it is referenced to heading.
Auto and manual elevation scale changing is inhibited.

C-Scope Auto Range/Elevation Coverage

AF RANGE (NM)	C-SCOPE ELEVATION GRID SCALES
< = 40	+/- 60°
80	+/- 30°
160	+/- 20°
240	+/- 10°

The azimuth scale will always be +/- 60°.

Default Selection

The DFLT softkey on the attack format selects the following default conditions, unless altered via PSMK:

– B-SP format
– Auto Plot Ageing
– 80 NM range scale,
– Any XY functions being carried out are cancelled and the XY marker is displayed in the default (marker locate) position
– Radar TWS
– 2 bars scan,
– Maximum scan width
– Azimuth and elevation scan centers set to zero if auto scan centering is not selected
– Auto scan OFF
– VISident is not preselected
– The search priority is set to AWS.

Normal Selection

The NORM softkey on the right MHDD will be available at the same position as the DFLT SK, when the format for the current POF is not the EF. It enables the default format to be displayed for each POF with associated default parameters for that format.

Pilot Selectable Multifunction Keys (PSMK)

The PSMK settings will be used as the initial set-up for the displays and radar selections, and when the default key is selected on the attack format, and the normal key is selected on the elevation format. The following settings can be predefined:

– PPI/B-SP (AF).
– C-Scope/Profile (EF).
– Default Scan Volume Settings:
  - semi-scan width on (AF)
  - number of bars: 1,2,4,6,8 on (AF)
– Default elevation height: 10, 20, 40, 60, 80, 100 kft on (EF)
– Display range: 4,10,20,40,80,160,240 (AF, EF)

– Velocity scale: +4500 to -900 / +1000 to - 900 kts (AF)
– AUTO scan centering: ON/OFF (AF)
– Plot ageing: AUTO, 5, 10, 15 seconds (AF)
– Search priority: AWS/PS/NORM (AF)
– Climb/Dive Ball (AF, EF)
– Canopy Outline (Image) (EF)
– Canopy Outline (Horizon Line) (EF)
– Outline Select

HUD Display

The following HUD symbology is presented for radar operation:

– ACMs Volumes (refer to Figure 1.273):
  • HUDACQ
  • VACQ
  • SACQ
– XY Marker
– VISident Positioning Cue
– VISident Target Information (Warning: Do not relay on radar derived information for safe separation)
  • Target Altitude (digits)
  • Target Range (scale, digits, circle)
  • Target Closing Speed (scale, digits)
  • Target Calibrated Airspeed (digits)
  • Target Track (digits)
– Minimum Radar Lock Range
– Steer Dot
– Lock On Symbol (refer to Figure 1.272)
– Target Designator (TD)

Targets are displayed on the HUD in three different sizes of Target Designation (TD) boxes to give an indication of track range. The largest TD box indicates range less than 10 NM, medium indicates between 10 and 20 NM, and the smallest indicates range between 20 and 40 NM. The TCRI for Unknowns and Hostiles will appear above the symbol. A maximum of 8 TD boxes can be displayed on the HUD at any one time. The TD box for the No. 1 DTL target is displayed on the HUD at all times; when the target moves out of HUD-FoV the TD moves along the HUD border and blinks. TD boxes, which have a medium range missile in flight against them (target in PETL) are marked by a cross and will disappear outside HUD-FoV.

Memorized objects are displayed as followed, because no color is available on HUD:

HUD Target Designator Symbology

OBJECT	RADAR TRACKED	RADAR MEMORIZED
Track	dashed, 4 dashes	dashed, 8 dashes
Target	single line	dashed, 8 dashes
1st Target	double line	dashed double line, 8 dashes

The target designator in the HUD is available in the following radar modes:

– Track While Scan (TWS)
– Single Target Track (SST)
– VISident and Gun.

In VISident mode the HUD is automatically decluttered, (general navigation information is occulted).

DVI (from PSC 2.0 onwards)

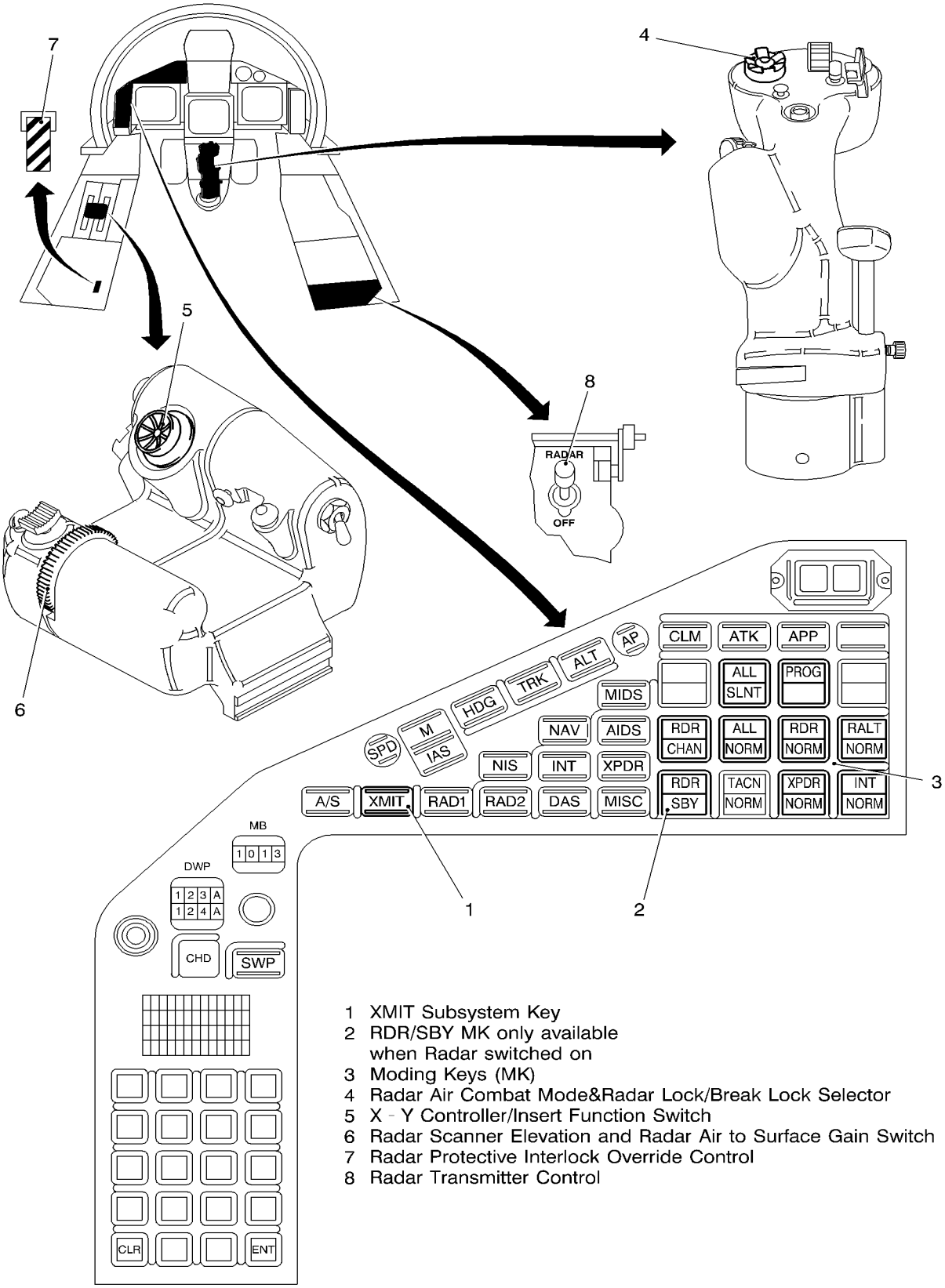
At IOC DVI will have no effect on the avionic sub-system apart from the Displays and Controls sub-system, which will simply provide visual feedback of command recognition in the HUD ROL.

DWP Warnings

The following warnings are available for the radar system:

Radar Failure Warnings

WARNING	DWP CAPTION	VOICE MESSAGE	SUPPRESS CONDITIONS	OTHER DISPLAY INDICATIONS
Radar Total Failure	**RADAR**	Radar	when OFF	all radar related information on EF, PA, AF occulted.
Radar Shutdown	**RADAR SD**	Radar Shutdown	No	No



1 XMIT Subsystem Key
2 RDR/SBY MK only available when Radar switched on
3 Moding Keys (MK)
4 Radar Air Combat Mode&Radar Lock/Break Lock Selector
5 X - Y Controller/Insert Function Switch
6 Radar Scanner Elevation and Radar Air to Surface Gain Switch
7 Radar Protective Interlock Override Control
8 Radar Transmitter Control

Figure 1.270 - Cockpit Controls

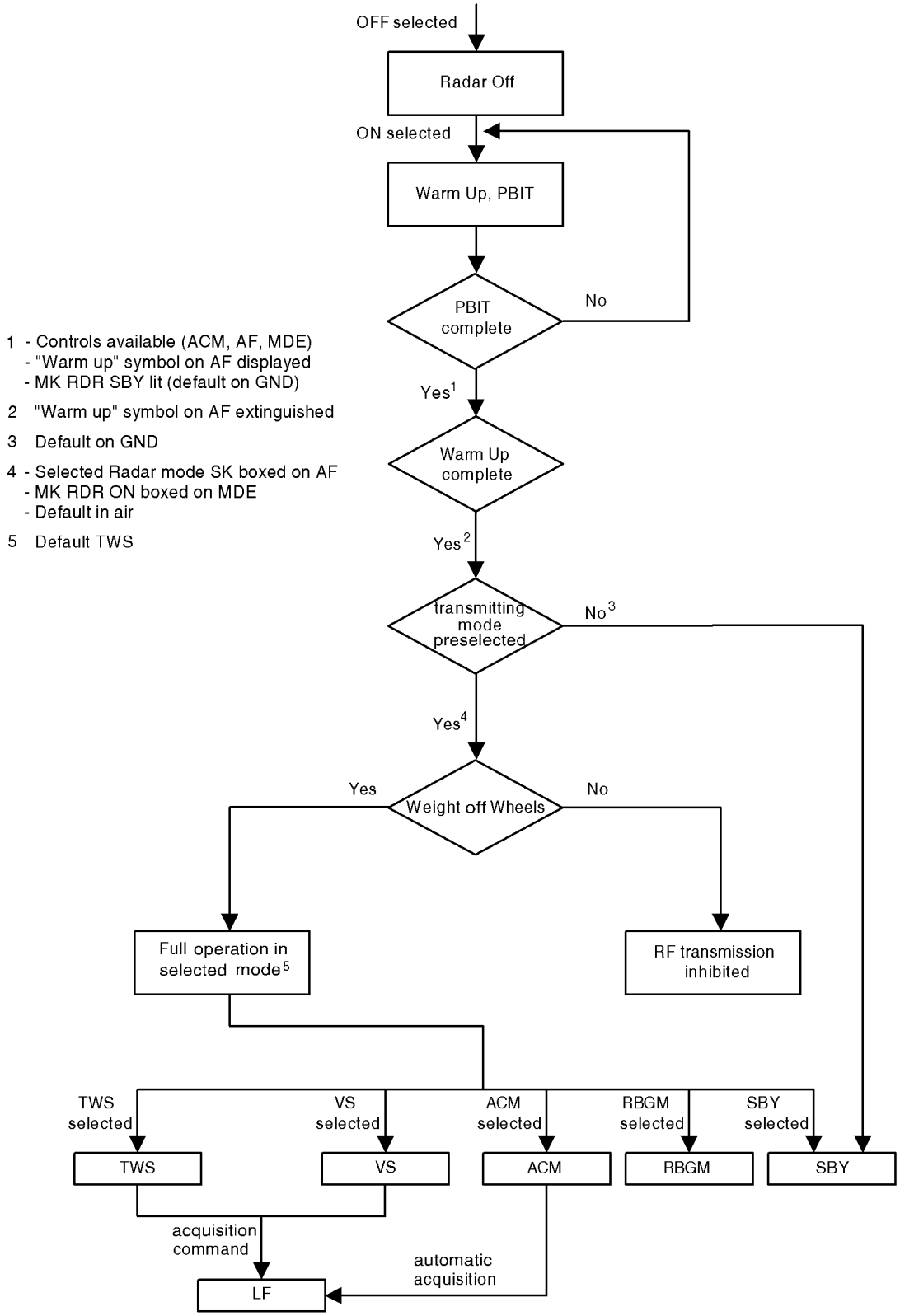


Figure 1.271 - Radar Moding

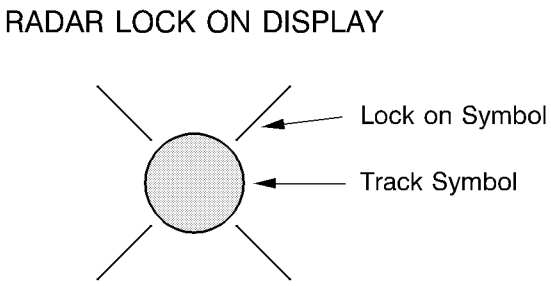
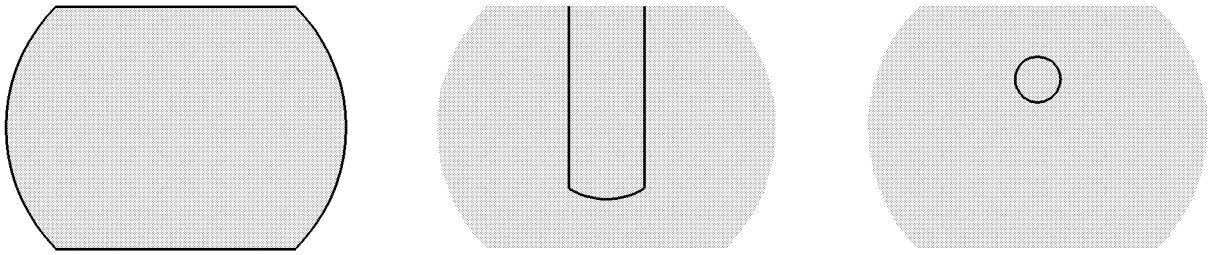


Figure 1.272 - Radar Lock On Symbol

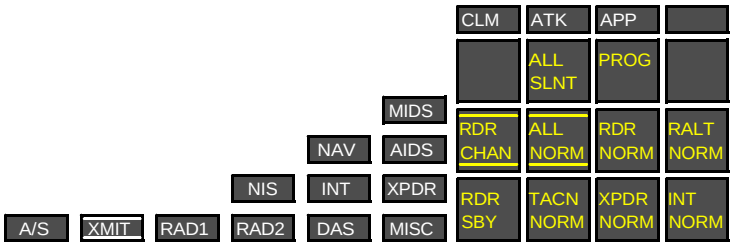


HUD Field of View Acquisition

Vertical Acquisition

Boresight/Slaved Acquisition

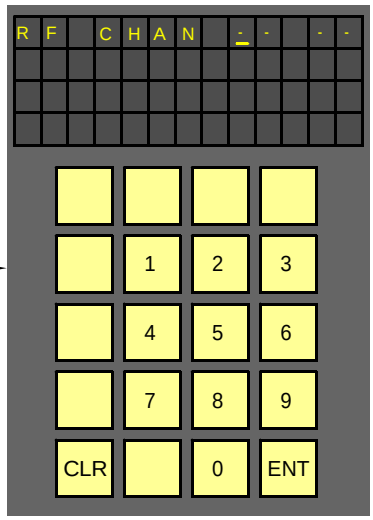
Figure 1.273 - HUD Indication - Air Combat Modes



PRESS THE **XMIT** SSK.

RDR SBY SHOWN BY DEFAULT ON POWER UP IF RADAR IS SWITCHED ON AND HAS PASSED PBIT.
IN SBY MODE THE RADAR'S TRANSMITTER AND RECEIVER ARE INHIBITED.

DEK AND ROL CONFIGURE TO ENABLE A PAIR OF RADAR CHANNEL NUMBERS TO BE ENTERED OR TO DISPLAY THE CURRENT CHANNEL PAIR AS NECESSARY.



NOTE
THE PRESELECTIONS FOR THE INDIVIDUAL TRANSMITTERS DEFAULT TO NORM, BUT CAN BE MODIFIED THROUGH A PDS LOAD

Figure 1.274 - Default Moding of the XMIT SS

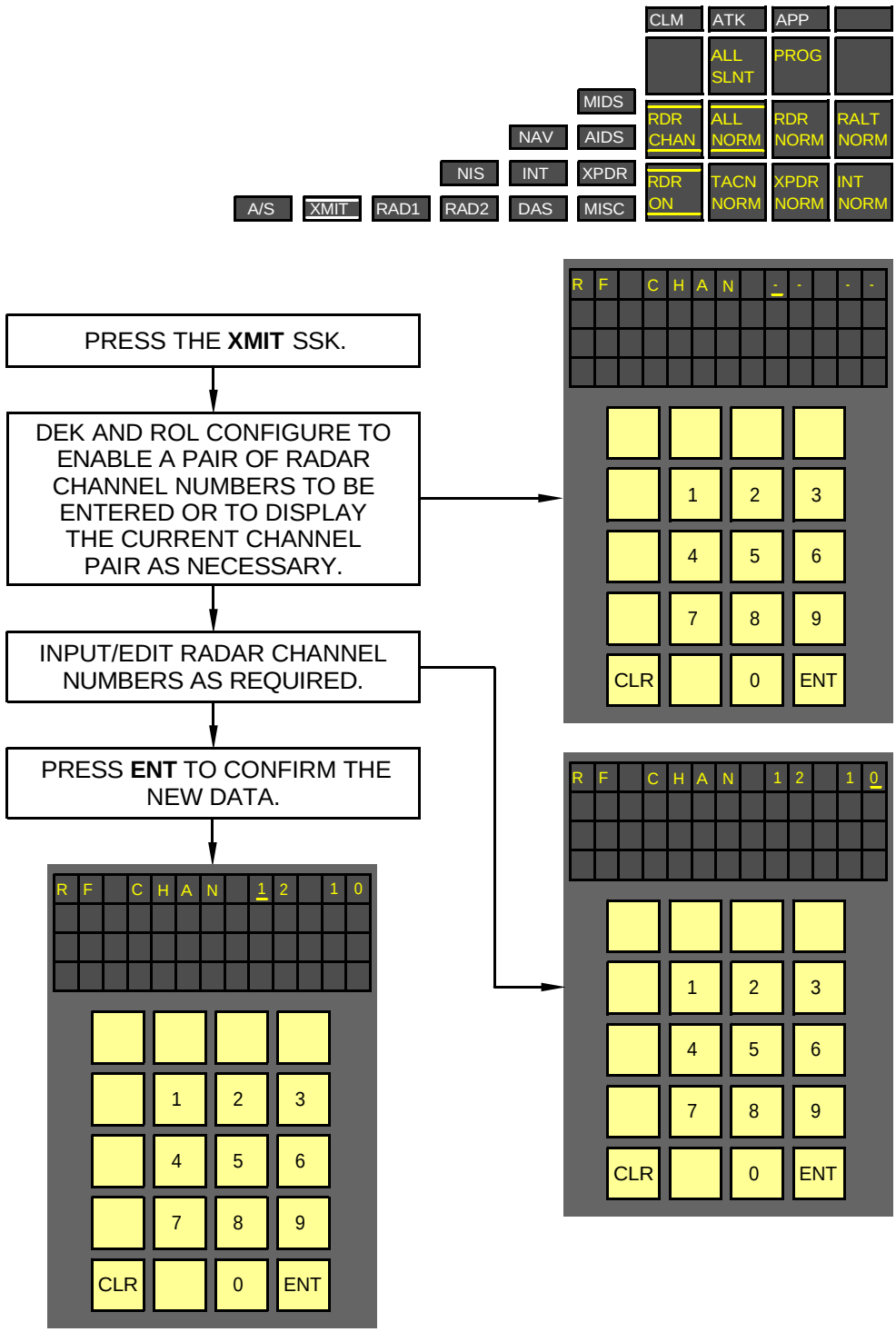


Figure 1.275 - Radar Operating Channel Specification

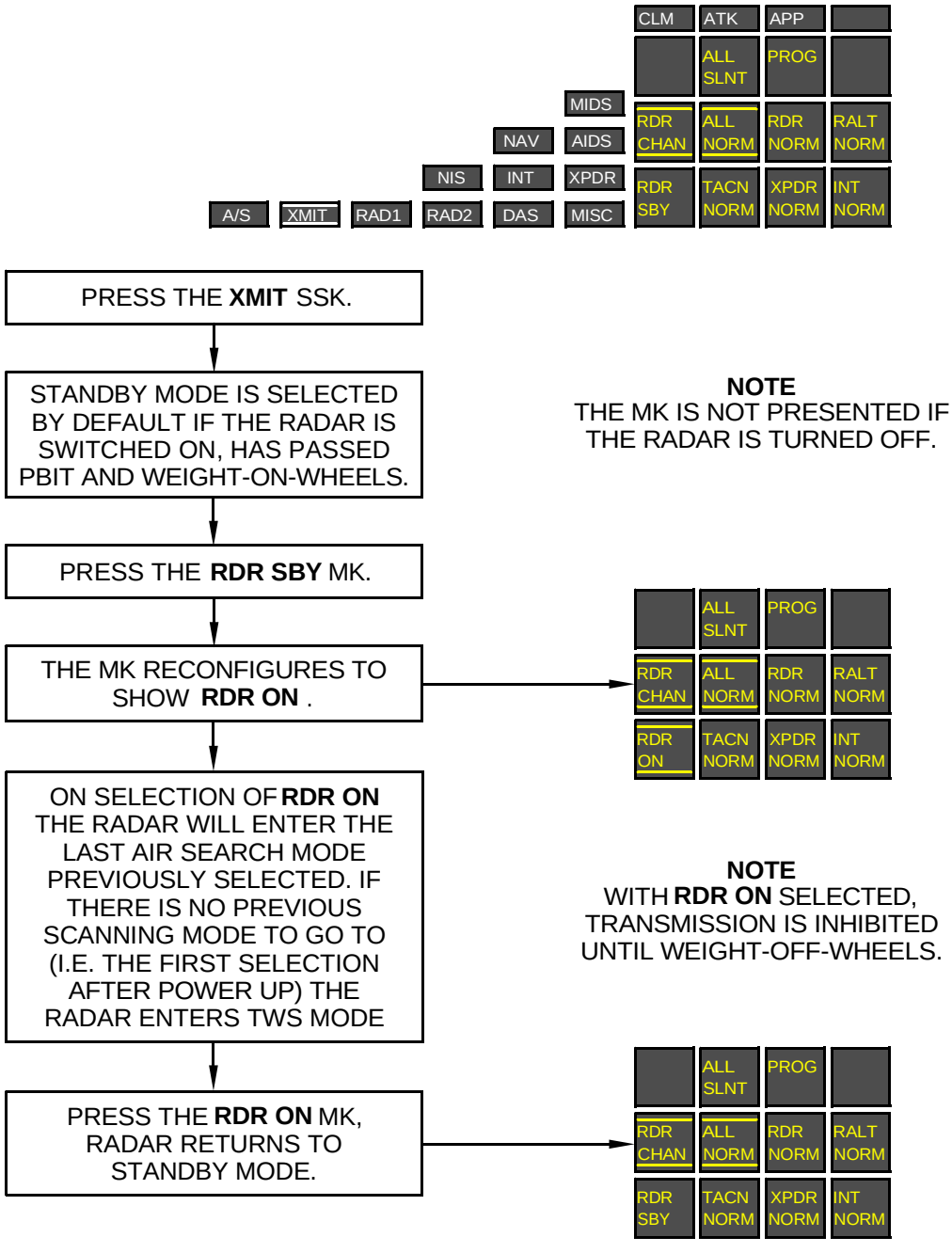


Figure 1.276 - Setting the Radar to ON or SBY

Identification System

(1B-B-93-40-00-00A-043A-A Issue 007)

Introduction

The Identification Friend or Foe System (IFF) comprises of the IFF Interrogator and the IFF Transponder. For identification of other aircraft the interrogator will transmit an interrogation signal which will or will not be answered by a recognizable transponder signal. The answers are then categorized friendly or unknown and are displayed against the radar plots.

IFF Interrogator (INT)

The IFF Interrogator function is to identify unknown platforms by updating their status from unknown to friendly. The result of the interrogation process will be displayed on the Attack and the PA Format.

The interrogator unit is installed in the avionics bay and consists of a control processor including transmitter and receiver and an aerial located on the radar antenna.

IFF Transponder (XPDR)

The IFF Transponder provides automatic self identification in response to interrogations from other platforms or transponds on pilot's action (IDENT) when requested by ATC.

The equipment is also capable to transmit EMERGENCY replies in either civilian or military modes as pre-selected by the pilot. On ejection the XPDR will transmit the military emergency distress code unless the unit is currently switched off.

The XPDR unit is installed in the avionics bay and consists of a control processor including transmitter and receiver and two IFF antennas; a Lower Antenna located on the left hand engine bay door and an Upper Antenna located forward of the cockpit windscreen. Replies will be transmitted through the antenna which received the strongest interrogation signal.

The transponder receives interrogation signals with a 1030 MHz carrier frequency, detects and decodes them and, in case of a correct interrogation transmits reply signals with a 1090 MHz carrier frequency.

Built In Tests (BIT)

A Power-up BIT, a Continuous BIT and an Initiated BIT will provide ground and in-flight failure detection and isolation within the transponder and the interrogator.

The Power-up BIT is performed when aircraft power is applied and OFF is deselected. During STANDBY and OPERATE conditions a Continuous BIT is automatically performed as long as the equipment is powered up. An Initiated BIT is selectable with the SK “A&I IBIT” on the Maintenance Format (MNTC) (available on the MHDD/ACUE format, on the ground only), from either STANDBY or OPERATE condition (without STEALTH) and will halt normal operation.

Power Supply

The interrogator will be supplied with 115 V single phase AC power and 28 V DC.

The transponder will be supplied from DC essential bus bar.

Identification System

(1B-B-93-40-00-00A-112A-A Issue 006)

General

The IFF transponder and interrogator operate in the following modes:

IFF/SSR Protocol Modes

The military modes (Identification Friend or Foe (IFF)) are defined by the numbers 1, 2, 3 and 4, and the civilian modes (Secondary Surveillance Radar (SSR)) are defined by the letters A, C and S. SSR modes, also called Air Traffic Control (ATC) modes, are also used by military aircraft. As IFF Mode 3 uses the same formats as SSR Mode A, it is called Mode 3/A. The IFF/SSR system operates in the following protocol modes:

Mode 1	Military mission identification code.
Mode 2	Military personal identification code.
Mode 3/A	Civilian and military ATC identification code.
Mode 4	Military identification, using one of two cryptovariable code sets (A or B) to encode the transmission signals and decode the replies. Mode 4 is only available if cryptovariables have been loaded. Cryptovariable data may be erased in emergencies or when not required anymore and will be erased automatically on ejection on either seat.

Mode C	Civilian and military aircraft barometric altitude information.
Mode S (Level 2 Basic Surveillance)	Civilian and military cooperative, surveillance and data link system for Air Traffic Management (ATM). Each Mode S equipped aircraft is assigned a unique address which allows interrogations to be directed to a specific aircraft.

In addition to the common modes there are the following specific modes for the interrogator and the transponder:

Interrogator Moding

Manual and Automatic Interrogations

Tracks may be interrogated either manually or automatically.

Plots may be interrogated manually by Area/Sector interrogation.

Automatic Interrogation (Autospecific Operation)

Autospecific interrogation is used to automatically interrogate new initiated radar tracks until a satisfactory response is received or the system failure criteria are met. The track is then classified, i.e. the track allegiance on the Attack, Elevation and Pilot Awareness formats is updated, but the response information is not displayed to avoid display clutter. The pilot can re-interrogate tracks manually at any time if confidence is lost in the track or for any other reason.

NOTE

When radar achieves lock from an ACM selection , the IFF interrogator automatically interrogates the resulting track whether AUTO SPFC is selected or not.

If the IFF is in Silent mode (stealth moding) when ACM is selected, it is automatically set to NORM. If ACM is subsequently cancelled by break lock, the IFF returns automatically to Silent mode. If ACM is cancelled by selecting another radar mode (e.g. TWS), the IFF and the radar remain in NORMal mode. To return to Silent mode the MDEF XMIT moding keys must be selected manually (displayed automatically when the new radar mode is selected).

Manual Interrogation

Manual interrogations are carried out in the following three ways:

Single Track Interrogation

Track interrogation by positioning the XY cursor on the track and pressing the stick top IFF interrogate button. The successful response will be used to update the track allegiance, on the Attack, Elevation and Pilot Awareness formats. The response information of the track is displayed on the AF when received for 5 seconds. Note, if the radar is locked to a track, IFF can be carried out directly by IFF interrogate press - there is no need to identify the track with the XY cursor.

Sector/Volume Interrogation

Sector interrogation (not available at PSP1) is used to interrogate objects in a defined search area / sector, which are not tracked by the radar. To interrogate a sector, place the XY cursor on an empty space on the AF and press the IFF Interrogate button on the Stick Top Controller. The sector will be displayed on the AF for 2 seconds to indicate that the sector has been selected and to select another sector size before the sector occults. Note that interrogation over a Track Group Symbol (TGS) will also perform a sector interrogation. The 25% and 50% areas are centered on the position defined by the XY cursor. The areas are selected sequentially, first press of the button giving 25%, second 50%, and third press the full screen. The sector width depends on the azimuth scan coverage selected on the radar. With area interrogation no radar track data correlation will be performed, therefore pure IFF-plots will appear which will be displayed for about 5 seconds. Correct responses are displayed as green circle IFF plots (friendly), all other replies as rectangular orange IFF plots (unknown).

All Tracks Interrogation

The INT ALL function on the MDEF INT SSK keyset will specifically interrogate all existing A/A radar tracks held within the system and within scan coverage for one time until a satisfactory response is received or the system failure criteria are met. Depending on the amount of tracks this interrogation may take a few seconds. Response information for each track will then be displayed for about 5 seconds and INT ALL will be deselected automatically. A manual track interrogation will interrupt the INT ALL function and will be continued when the manual track interrogation is finished.

Automatic Code Change

This facility enables automatic selection and use of Mode 1 and 3/A codes, with the codes automatically changing at pre-defined times. The code set to be used, the start time, and the time interval between changes are loaded via PDS. The Mode 1 and 3/A codes in use at the time and the time remaining for operation in Automatic Code Change (ACC), are shown on the MDEF ROLS if the CODE INFO moding key is selected. If no ACC codes have been loaded, or the ACC time is invalid, the ACC/MAN moding key is occulted and ACC mode cannot be selected. If codes have been loaded and ACC time is valid but ACC has not been selected, a prompt is displayed on the Autocue format in GND POF. A voice warning prompt ("INTERROGATOR ACC AVAILABLE") is given when in NAV and AA POF if the ACC conditions become valid and whenever there is a change between these POF during flight and ACC is available but not selected.
If ACC codes have been loaded for only one mode, the other mode will automatically be forced into active decode operation, see below.

Active Decode

If the Active Decode facility is selected (ACTV DCDE), the received Mode 1 and 3/A codes are shown on the Attack Format as 2 digit (mode 1) and 4 digit (mode 3/A) readouts adjacent to the associated track symbol or plot when a manual interrogation has been selected. The readouts occult after 5 secs.
The response codes of targets or tracks which have been interrogated in Mode 2 are not displayed.
Active decode may be used for both specific and area interrogations.

Forced Active Decode

If no codes have been loaded for modes 1 or 3/A then Active Decode will automatically be initiated for the modes which do not have codes defined since comparison with interrogation codes is not possible. Forced Active Decode responses will not provide identity inputs to the correlation process for tracks or plots. The Forced Active Decode selection will not be indicated via the MDE.

Mode 4

Mode 4 uses codes based on one of two crypto sets (A or B) stored within the system. The desired set is selected by sequential presses of the Mode 4 MK. Cryptovariable data may be erased in emergencies or when not required anymore via the Secure Data Erase switch and will be erased automatically on ejection.
When Mode 4 is selected and the transponder replies correct to a challenge this will be indicated on the Attack Format for a minimum of 1 second. This indication can be deselected using the XY controller on the Mode 4 response icon.
When Mode 4 is selected and the interrogator receives an incomplete Mode 4 response this is indicated with the associated track, target, or IFF plot on the Attack Format by the characters “MODE4”.
A truncation function stops Mode 4 interrogations when the reply is correct to minimize the enemy's ability of analyzing the used crypto codes.

NOTE

NATO operating procedures currently restrict the use of Mode 4 with other mode selections to C2 units, AEW units and CRCs, and inhibits Mode 4 sector interrogations. However the system selection of Mode 4 with other modes will not be inhibited since NATO operational procedures may change.

IFF Training Mode (not available at PSP1)

A training mode is implemented, allowing the use of IFF responses from interrogated tracks to change the display of allegiance of specific tracks. The facility is accessed through the MDEF on the second page in the INT sub-system. The training mode selection will only be available when Mode 1 and ACTV DCDE is selected.
To cancel training mode deselect either training mode, or ACTV DCDE, or Mode 1, or clear one or both training codes.

Prebriefed Training Mode

The pilot may enter (manually, or via PDS) two Mode 1 codes, one for exercise "friendlies", and one for "hostiles" - termed fakers. In flight, when training mode has been selected, the weapons system will display all those tracks responding with the friendly squawk as Friendlies, those with the faker squawk as Hostiles, and all other tracks as Unknowns.

Target of Opportunity Training Mode

If defined opponents are not available (no codes loaded), the TOO training mode will display tracks as friendly if that transponds with the defined “friendly” training code. All other tracks will be displayed as hostile.

Pilot Identity Override

The pilot may override the system defined identity of a track using the XY controller with the Pilot Identity Override icon on the Attack Format. Refer to Attack and Identification System - Sensor Fusion

Surveillance/Attack and Identification Subsystem pag. 1-457.

Default Moding

On initial power up, several modes are automatically selected as default; the pilot may change these at any time, and the revised settings are retained for use thereafter. The default mode selections are:

– NORM (transmission inhibit by WoW on GND)
– Mode 1
– Mode 3A
– 1/3A CODE (MDE DEK & ROL are configured for manual entry of mode 1 and 3 codes)
– MANual (ACC/MAN MK is not present if ACC codes are not loaded or no longer valid. System will operate in MAN mode.)
– AUTO SPFC

All other modes are deselected.

Transponder Moding

Automatic Code Change

This facility enables automatic selection and use of Mode 1 and 3/A codes, with the codes automatically changing at pre-defined times. The code set to be used, the start time, and the time interval between changes are loaded via PDS. The Mode 1 and 3/A codes in use at the time, and the time remaining for operation in ACC, are shown on the MDEF ROLS if the CODE INFO moding key is selected. If no ACC codes have been loaded, or the ACC time is invalid, the ACC/MAN moding key is occulted and ACC mode cannot be selected. If codes have been loaded, and ACC time is valid, but ACC has not been selected, a prompt is displayed on the Autocue format in GND POF. A voice warning prompt ("TRANSPONDER ACC AVAILABLE") is given when in NAV and AA POF if the ACC conditions become valid and whenever there is a change between these POF during flight and ACC is available but not selected.
If codes have only been loaded for one mode then the ACC operation will only apply for this mode.

Mode S (Level 2 Basic Surveillance)

The Mode S will allow to interrogate more data from specific aircraft which can include:

– Mode 3/A Code
– Mode C Barometric Altitude (-1000 to +126750 ft).
– Aircraft Registration Number or Aircraft Identification.
– Mode S Aircraft Address.
– On-Ground Indicator.
– Maximum Cruising True Airspeed.
– Data Link Capability Report.

MIL/CIV

Selects either the civilian or military emergency code which will be transmitted by the Emergency function on the RHGS. The two modes are mutually exclusive, the default being MIL.
On ejection the system will transpond on the military code unless the unit is currently switched off.

Emergency

To transmit either MIL or CIV emergency distress codes select the EMGY button on the RHGS. The modes required for military emergency operation (Mode 1, 2, and 3) and for civilian emergency operation (A and S) will be as selected via the MIL/CIV key. Stealth state and Stby will be overridden during that time. Upon deselection of the emergency mode the transponder will return to normal or STBY operation as selected.

NOTE

The EMGY function is not available when transponder is switched OFF.

Upon ejection the IFF XPDR will automatically transpond on the military modes unless the unit is currently switched off.

Identification

The Ident function (ID) will transpond in Mode 1, 2, 3/A and S for about 20 seconds if this modes are selected, a minimum of one mode must be selected. When ID is re-triggered within that period the time is extended accordingly. Stealth state will be overridden during that time.

Default Moding

On initial power up, several modes are automatically selected as default; the pilot may change these at any time, and the revised settings are retained for use thereafter. The default mode selections are:

– SBY
– Mode 1
– Mode 2
– Mode 3A
– Mode 4A (when codes are loaded only)
– Mode C
– MIL
– 1/3A CODE (MDE DEK & ROL are configured for manual entry of mode 1 and 3 codes
– MANual (ACC/MAN MK is not present if ACC codes are not loaded or no longer valid. System will operate in MAN mode.)

– Mode 4 response icon on AF is set to ON

All other modes are deselected.

Identification System

(1B-B-93-40-00-00A-111B-A Issue 003)

General

This module contains images of MHDD formats that are associated with data modules Identification System pag. 1-539 and Identification System pag. 1-539.

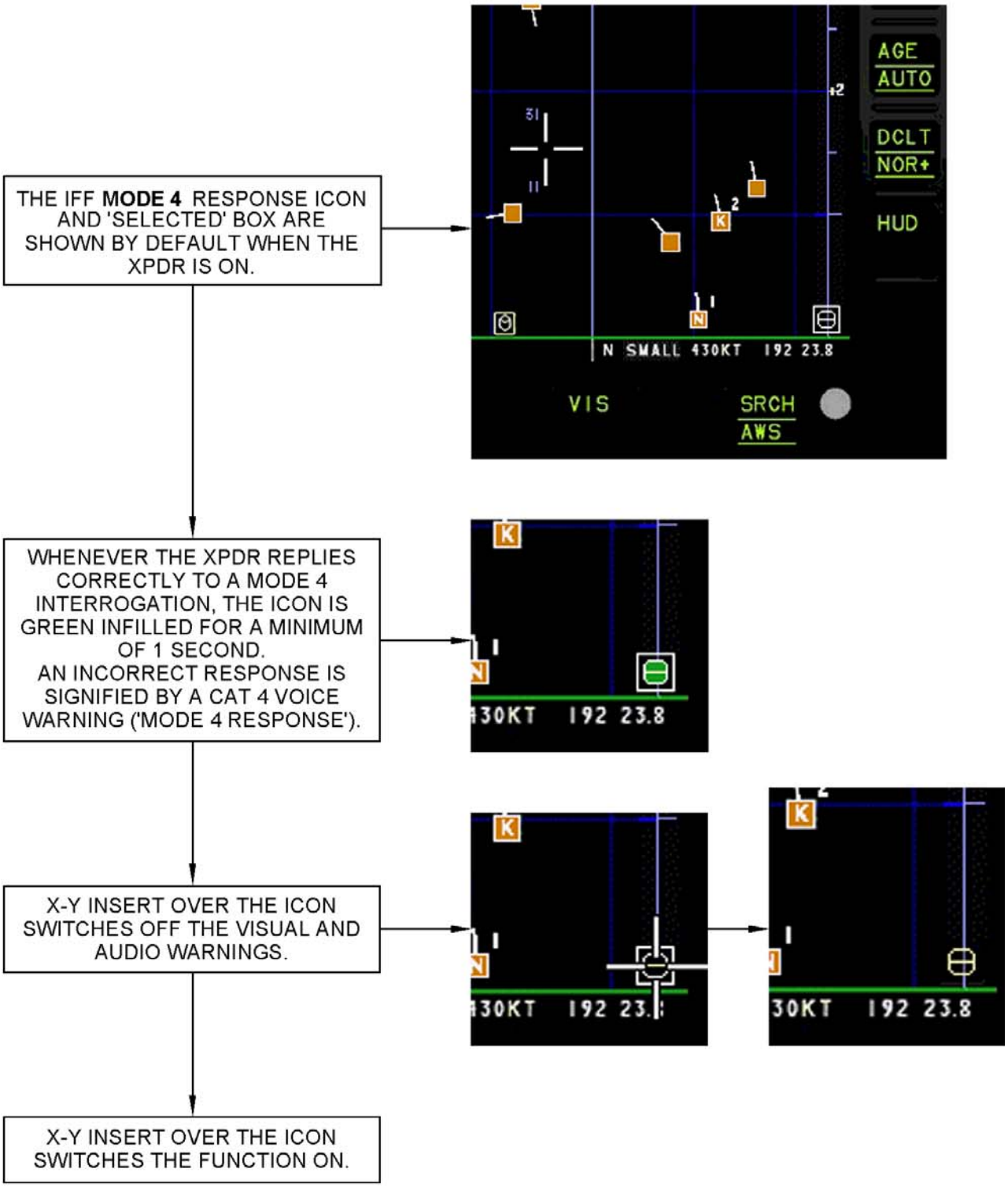

THE IFF **MODE 4** RESPONSE ICON AND 'SELECTED' BOX ARE SHOWN BY DEFAULT WHEN THE XPDR IS ON.
AGE
AUTO
DCLT
NOR+
HUD
N SMALL 430KT 192 23.8
VIS
SRCH
AWS
WHENEVER THE XPDR REPLIES CORRECTLY TO A MODE 4 INTERROGATION, THE ICON IS GREEN INFILLED FOR A MINIMUM OF 1 SECOND.
AN INCORRECT RESPONSE IS SIGNIFIED BY A CAT 4 VOICE WARNING ('MODE 4 RESPONSE').
X-Y INSERT OVER THE ICON SWITCHES OFF THE VISUAL AND AUDIO WARNINGS.
X-Y INSERT OVER THE ICON SWITCHES THE FUNCTION ON.

Figure 1.277 - Own Mode 4 Response

POSITION THE X-Y MARKER AT THE CENTER OF A VOLUME OF AIRSPACE OR OVER A TGS THAT IS TO BE INTERROGATED (**ATK** FORMAT).

SELECT THE VTAS IFF INTERROGATE CONTROL. A SECTOR SIZED AT 25% OF THE SELECTED RANGE SCALE AND MAXIMUM SELECTABLE AZIMUTH LIMIT IS DISPLAYED CENTERED ON THE X-Y POSITION.

THE SECTOR IS DISPLAYED FOR THE DURATION OF THE INTERROGATION OR FOR 2 SECONDS, WHICHEVER IS THE LONGEST.
IFF PLOTS DETECTED IN THIS VOLUME WILL BE DISPLAYED FOR 5 SECONDS.

INDICATES FRIENDLY IFF PLOT.

INDICATES A DEFINITELY FRIENDLY PLOT (MODE 4 RESPONSE)(BAND ONLY SHOWN FOR ONE RADAR FRAME TIME).

INDICATES UNKNOWN IFF PLOT.

NOTE
IFF PLOTS ARE OF A LOWER PRIORITY THAN TRACKS AND WILL THEREFORE BE OVERWRITTEN BY TRACK SYMBOLOGY, WHERE APPLICABLE.

PROVIDED THE X-Y MARKER IS NOT MOVED, SUBSEQUENT IFF INTERROGATE SELECTIONS WITHIN 2 SECONDS WILL SELECT A 50% SECTOR SIZE FOLLOWED BY A 100% SECTOR SIZE.

AN IFF SELECTION WITHIN 2 SECONDS WITHIN THE 100% SECTOR WILL SELECT THE 25% SECTOR SIZE.

NOTE
CORRELATION WITH RADAR TRACK DATA IS NOT PROVIDED FOR VOLUME INTERROGATIONS.

Figure 1.278 - Manual Interrogation of a Volume of Space

Identification System (IFF)

(1B-B-93-40-00-00A-111A-A Issue 006)

Right Console - Gangbar

IFF Transponder switch

The two positions of the toggle switch are labelled XPDR and OFF. Following XPDR switch on and completion of the PBIT, the transponder is automatically defaulted to the standby mode of operation “SBY”.

IFF Interrogator switch

The two positions of the toggle switch are labelled INT and OFF. Following Interrogator switch on and completion of the PBIT, the Interrogator is automatically defaulted to the normal mode of operation “NORM” and will operate and transmit normally, unless:

1 The stealth requirements (SLNT) are selected via MDE.

2 INT STBY has been selected via MDE.

3 Inhibited by WOW.

Left Console

SECURE DATA ERASE switch

The coverguarded switch SECURE DATA ERASE will erase all loaded secure data of the XPDR and Interrogator.

Left Hand Glareshield (LHGS)

The following Sub-System Keys are used to manage the Interrogator and Transponder:

INT (SSK)

The INT SSK will enable the following set of Moding Keys (MK), refer to Figure 1.279.

SBY/NORM

In SBY all interrogator functions are available and preselectable but interrogator transmissions are inhibited, refer to Figure 1.280.

In NORM (selected by default) the interrogator is fully operational with the modes selected. Transmissions are inhibited when WOW signal present and are automatically enabled when weight is off the wheels. The control is moded independently from the INT stealth control.

MODE 1

Selects or deselects Mode 1 (selected by default), refer to Figure 1.281.

MODE 2

Selects or deselects Mode 2, refer to Figure 1.282.

MODE 3A

Selects or deselects Mode 3A (selected by default), refer to Figure 1.283.

PAGE 2 (CODE INFO)

Reconfigures the MKs to display the CODE INFO MK, which shows the time left for all the ACC codes currently stored and the current codes selected for the modes 1/3A currently in use. The time shown is always related to ACC codes and therefore independent of manually entered codes in use, refer to Figure 1.284.

The Page 2 MK remodes to Page 1 and will call up page 1 again.

MODE 4

First press selects Mode 4 A, second press selects Mode 4 B and third press deselects Mode 4 (Mode 4 MK is only available if cryptovariables are loaded), refer to Figure 1.285.

Cryptovariable data may be erased in emergencies or when not required anymore by use of the SECURE DATA ERASE switch and will be erased automatically on ejection of either seat.

MODE C

Selects or deselects Mode C, refer to Figure 1.286.

ACTV DCDE

This enables the active decoding and display of the Mode 1 and 3A codes of the responding target on the MHDD, refer to Figure 1.287.

1/3A CODE

Independently to the PDS loaded ACC code pairs, eight pairs of codes for Mode 1 and 3A can be entered manually and selected with the DEK brackets. Changing a pair of codes will be active on pressing ENTer. The 1/3A key (selected by default) is available independently from ACC/MAN selection, refer to Figure 1.288 and Figure 1.289.

ACC/MAN

ACC enables Automatic Code Change of Mode 1 and 3A codes, using a PDS-loaded code set, refer to Figure 1.290.

MANual code change (selected by default) uses manually entered codes for Mode 1 and Mode 3A. ACC is inhibited when this function is selected.

The ACC/MAN key is only available when ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from

the GPS). When the ACC is not loaded or is no longer valid the MK legend is occulted and manual code change is automatically selected by the system. If codes have only be loaded for one mode then the ACC operation will only apply for this mode. The codes may be entered manually via MDEF (1/3A Code).

AUTO SPFC

Selects Auto Specific interrogation (selected by default), i.e. a track is automatically interrogated on track initiation, refer to Figure 1.291.

INT ALL

The system interrogates all existing A/A radar tracks held within the system and within scan coverage. On completion of the interrogations the mode is automatically deselected. Subsequent selections of the MK before auto-deselection will have no effect on the displays but will request fresh interrogations of all tracks. Successful response will be indicated on the Attack, Elevation and Pilot Awareness formats for 5 seconds after the response of the last track, refer to Figure 1.292.

XPDR (SSK)

Selection of the XPDR SSK will enable the following set of Moding Keys (MK), refer to Figure 1.293:

SBY/NORM

In SBY (selected by default) the XPDR will still receive interrogations, but will not reply unless emergency is selected. All XPDR functions are available and preselectable, refer to Figure 1.294.

In NORM the XPDR is fully operational with the modes selected and transmissions are not inhibited by WOW to allow ATC interrogation on ground. The control is moded independently from the XPDR stealth control.

MODE 1

Selects or deselects Mode 1 (selected by default), refer to Figure 1.295. The XPDR can only respond in Mode 1 when an operating code is available. The last code is held in the Non Volatile Memory (NVM) until overwritten by a new code. Codes can be entered via the MDEF or loaded via PDS.

MODE 2

Selects or deselects Mode 2 (selected by default), refer to Figure 1.296. The XPDR can only respond in Mode 2 when an operating code is available, either loaded via PDS or from the Non Volatile Memory (NVM). The last code is held in NVM until overwritten by a new code.

MODE 3A

Selects or deselects Mode 3A (selected by default), refer to Figure 1.297. The last code is held in the Non Volatile Memory (NVM) until overwritten by a new code. Codes can be entered via the MDEF or loaded via PDS.

CODE INFO

Shows the time left for all the ACC codes currently stored and the current codes selected for the modes 1/3A currently in use. The time shown is always related to ACC codes and therefore independent of manually entered codes in use, refer to Figure 1.298.

MODE 4

MODE 4A is selected by default, indicated on the boxed MK MODE 4A, refer to Figure 1.299. Next presses will toggle through MODE 4B, deselection of MODE 4 and selection of MODE 4A again. If no Mode 4 cryptos have been loaded, the MK is occulted and the mode cannot be selected. Cryptovariable data may be erased by use of the SECURE DATA ERASE switch and will be erased automatically on ejection.

MODE C (MK)

Selects or deselects Mode C (selected by default), refer to Figure 1.300.

NOTE

The XPDR receives the altitude information directly from two Flight Control Computers. In case that no valid altitude information is available the XPDR will transmit altitude zero.

MIL/CIV

Selects between MIL and CIV emergency codes transmitted when EMGY is selected (default is MIL), refer to Figure 1.301.

1/3A CODE

Independently to the PDS loaded ACC code pairs, eight pairs of codes for Mode 1 and 3A can be entered manually and selected with the DEK brackets, refer to Figure 1.302 and Figure 1.303. Changing a pair of codes will be active on pressing ENTer. The 1/3A key (selected by default) is available independently from ACC/MAN selection.

ACC/MAN

ACC enables Automatic Code Change of Mode 1 and 3A, using a PDS-loaded code set, refer to Figure 1.304.

MANual code change (selected by default) uses manually entered codes for Mode 1 and Mode 3A. ACC is inhibited when this function is selected.
The ACC/MAN key is only available when ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from the GPS). When the ACC is not loaded or is no longer valid the MK legend is occulted and manual code change is automatically selected by the system. If codes have only be loaded for one mode then the ACC operation will only apply for this mode. The codes may be entered manually via MDEF (1/3A Code).
The currently selected state, i.e. ACC or MAN is also displayed on the RGS.

MODE S

Selects or deselects the ATC Mode S, refer to Figure 1.305.

NOTE

The SK Mode S will only be displayed if valid Mode S data is loaded into the transponder.

XMIT (SSK)

After power up the SSK XMIT is available for selection. The following Moding Keys (MK) are enabled to manage the IFF interrogator and transponder transmissions, refer to Figure 1.306.

ALL NORM

Boxed by default, indicating that all transmitters are enabled for transmitting. The MKs for the individual transmitters are displayed for pre-selections of the program mode. This MKs are default to NORM when XMIT is pressed, but can be modified through a PDS load.

ALL SLNT

If selected ALL SLNT is boxed indicating that all transmitters are inhibited from transmitting.

PROG

If selected PROG is boxed; ALL NORM or ALL SLNT MK are deselected. Any of the system controls set to SLNT will be boxed, those set to NORM will not be boxed.

XPDR NORM/SLNT; INT NORM/SLNT

This individual transmitter MKs act as preselectors when PROG is not selected. The pre-selections for the individual transmitters are default to NORM when XMIT is pressed, but can be modified through a PDS load. When ALL NORM is selected (boxed) any selection of an individual transmitter key will preselect the relevant transmitter to either SLNT or NORM. The MK legend toggles between SLNT and NORM. The SLNT keys are only boxed when PROG is selected (boxed).

MISC (SSK)

CRYP SUPP

With MISC selected the MK CRYP SUPP will be available. Selection of the MK CRYP SUPP (boxed) will suppress all cryptovariable related warnings (Voice, DWP and Autocue Format) with the following restriction. If any of the following four warnings occur, RAD1, RAD2, XPDR or IFF INT the suppression is removed and the warning(s) shown. The MK will be deselected and must be reselected for the suppression to be enabled again. If cryptovariables are loaded suppression is not available and will be removed (unboxed). Deselection of the CRYP SUPP (unboxed) will remove the suppression of the cryptovariable related warnings.

Right Hand Glareshield (RHGS)

RGS Flap

The system status (SBY, ACC, MAN, SLT) and currently selected modes are displayed on the RGS flap.

NOTE

Note that if standby and silent are both selected, then “SLT” will be displayed.

Transponder Emergency Control

Pressing the recessed EMGY pushbutton on the RHGS will start transmission, upon interrogation, of either MIL or CIV emergency codes as preselected. A second press deselects the transmission of the EMGY code. Stby and stealth state will be overridden during that time.

Identification Response Selection

The identification pushbutton, labelled ID, is used to transpond for about 20 seconds when requested by ATC. The ID button will not be illuminated in SBY. Stealth state will be overridden during that time.

HOTAS

Stick Top

The pilot initiates track or area interrogation, and defines the interrogation volume, using the IFF interrogate button on the stick top.

Throttle Top

The XY controller is used for the following IFF functions:

- IFF Mode 4 Own Aircraft Response ON/OFF selection via XY on icon (AF)
- Manual IFF interrogation of tracks, targets (including TGS) or volumes (volumes not available at PSP1) (AF)
- Pilot Identity Override (PIO) (AF)
- IFF Extra Information

For detailed XY-controller operation refer to Identification System pag. 1-543.

Attack Format

IFF returns are displayed on the AF as green (friendly) or amber (unknown) plots or as track attributes. The plots are of a lower display priority than track symbols, and are therefore usually overwritten. A successful interrogation may convert an unknown track into a friendly, and the track symbol may then change accordingly to a green infill circle.

The allegiance can be overwritten by use of the Pilot Identity Override Icon.

The Mode 4 Response Icon is used to select the Own Challenge Reply Indication and the CAT 4 Incorrect Own Response Warning to on or off, using the XY controller (default is on). When selected to on, the icon is shown as a box with a bright white circle with a dull white line through the circle. When correct response was sent the circle will get a green infill inside for a minimum of 1 second. When selected to off a dull white circle with dull white line through the circle will be shown with black casing.

Mode 4 Challenge Reply Indication (from PSP 2.0 onwards) is provided for a minimum of 1 seconds.

The area interrogation box (from PSP 2.0 onwards) is drawn on the attack format for the duration of the sector interrogation or for 2 seconds whichever is the longest, when selected by the pilot. Three areas are available, 25% of the display area (defined as 25% of the current range scale long by 25% of the total scan width wide), 50%, and 100%. The 25 and 50% areas are nominally centered on the position defined by the XY cursor. The areas are selected sequentially, first press of the button giving 25%, second 50%, and third press the full screen.

To avoid unnecessary IFF transmissions, IFF informations already available for a track will be displayed when extra information is selected on that track using the XY controller. Mode C altitude information is excluded.

Mode 1 and 3A codes of the responding target are displayed with white digits next to plots, tracks and targets when active decoding is selected.

Mode C Altitude is displayed in whole thousands of feet with plots, tracks and targets for 5 seconds when interrogated.

EMGY will be displayed when a military emergency code has been received against a track or target. EMGY will always shown in the top code position, if other codes are already displayed they will move down one position.

Pilot Awareness/Elevation Format

The result of the identification process will be displayed as track allegiance (color and format).

Reversionary MDE Format

The MHDD Reversionary MDE format can also be used for transmit inhibit control and Mode 4/4A/4B selections in case of left glareshield malfunctions.

Autocue Format

The following prompts are displayed for the IFF system during ground operation:

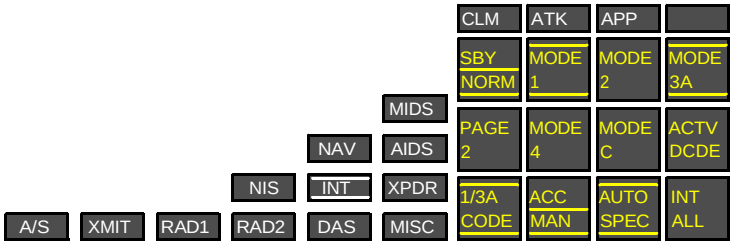
- “SYSTEMS GANGBAR” when the transponder or interrogator is off after engine start.
- “ACC AVAILABLE” when power is on and ACC codes are loaded and the current ACC code start time is less or equal to the present UTC time (from the GPS) but ACC is not selected.
- “CRYP ERROR IFF XPDR” when power is on and cryptovariables are not available/loaded.
- “CRYP ERROR IFF INT” when power is on and cryptovariables are not available/loaded.

IFF Warnings/Failures

The following warnings are available for the IFF system:

IFF Failure Warnings

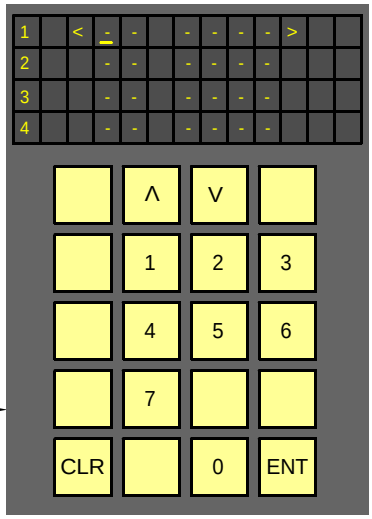
WARNING	CATEGORY	DWP CAPTION	VOICE MESSAGE	SUPPRESS CONDITIONS	OTHER DISPLAY INDICATIONS	MISSION CONSEQUENCES
Transponder Failure	3	**XPDR**	Transponder	when OFF	No	Transponder lost
Interrogator Failure	3	**IFF INT**	Interrogator	when OFF	No	Interrogator lost
IFF INT or XPDR Cryptovariable Failure	3	**IFF CRYP**	IFF Crypto	manually selectable	on Autocue	Mode 4 lost
Mode 4 incorrect own response	4	None	Mode 4 Response	when alerting mode deselected (Icon)	No green infill for one second in Response Icon on PA and AF	Self identification possibly incorrect
Mode 4 incomplete Target response	N/A	N/A	N/A	N/A	indicated by “MODE 4” with the associated IFF track or plot on the AF	N/A
IFF Interrogator Overtemperature	3	**INT T**	Interrogator Temp	None	None	None, but may lead to Interrogator Failure
IFF Transponder ACC available	4	None	Transponder ACC available	when ACC already selected	None	None
IFF Interrogator ACC available	4	None	Interrogator ACC available	when ACC already selected	None	None



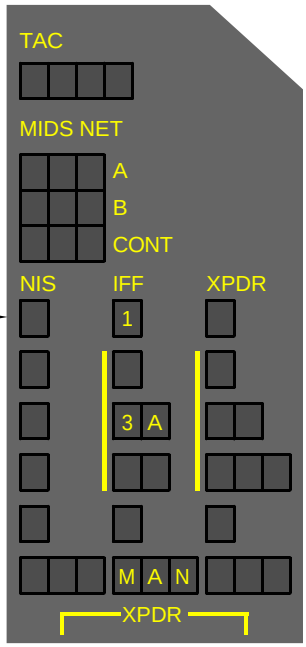
PRESS THE **INT** SSK.

SYSTEM DEFAULTS INCLUDE:
- NORM MODE
- MAN MODE
- AUTO SPFC MODE
- MODE 1
- MODE 3A
- 1/3A CODE ENTRY.

DEK AND ROL CONFIGURE TO ENABLE MODE 1/3A CODE INSERTION.



CURRENT INTERROGATOR MODING IS ALSO DISPLAYED ON THE RGS FLAP.



DEFAULT MODING

NOTE
IF ACC IS NOT LOADED OR NO LONGER VALID, THEN THE **ACC/MAN** MK LEGEND IS NOT PRESENTED AND THE SYSTEM WILL OPERATE IN MAN MODE.

Figure 1.279 - Default Moding of the INT SS

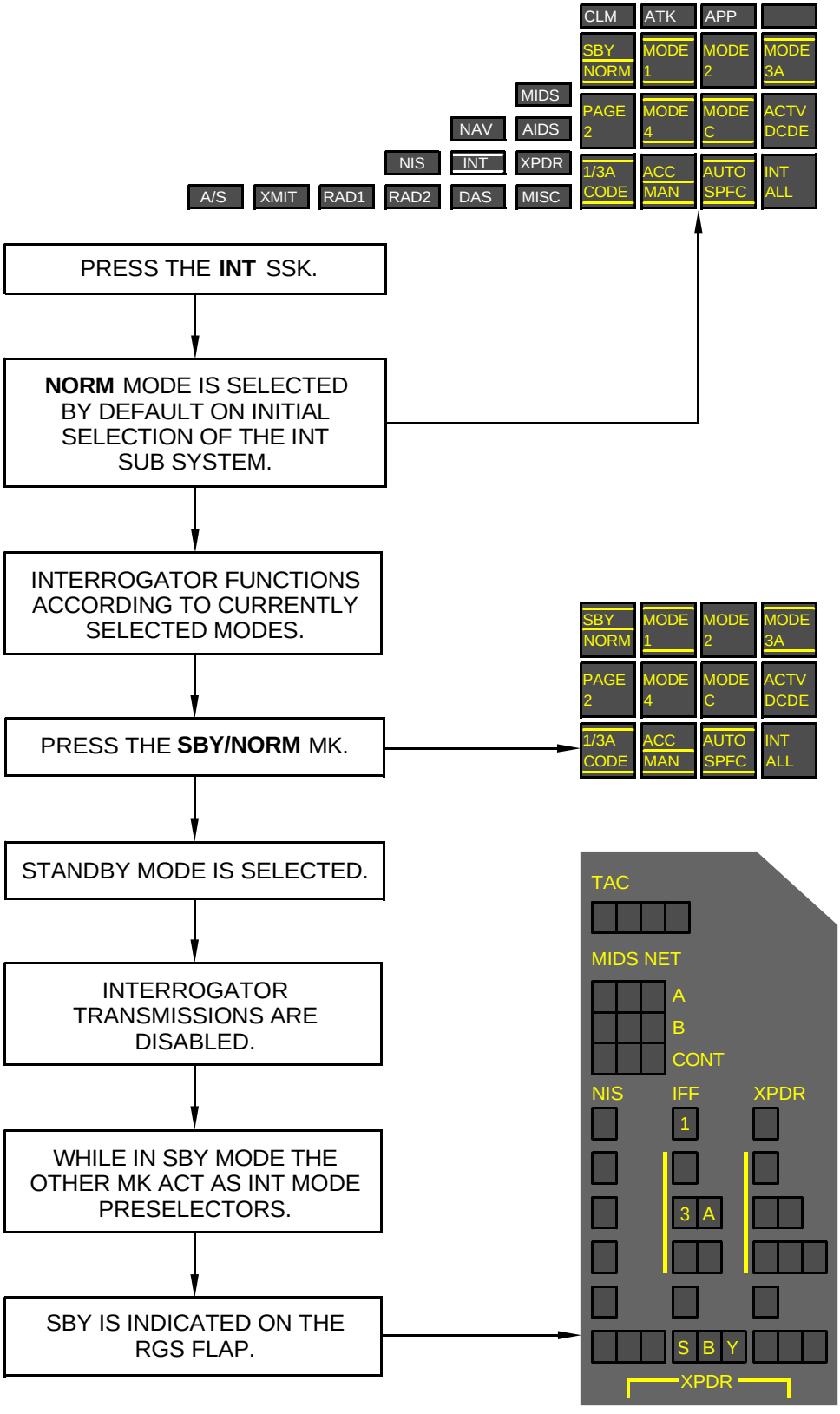


Figure 1.280 - INT Standby/Normal Mode Selection

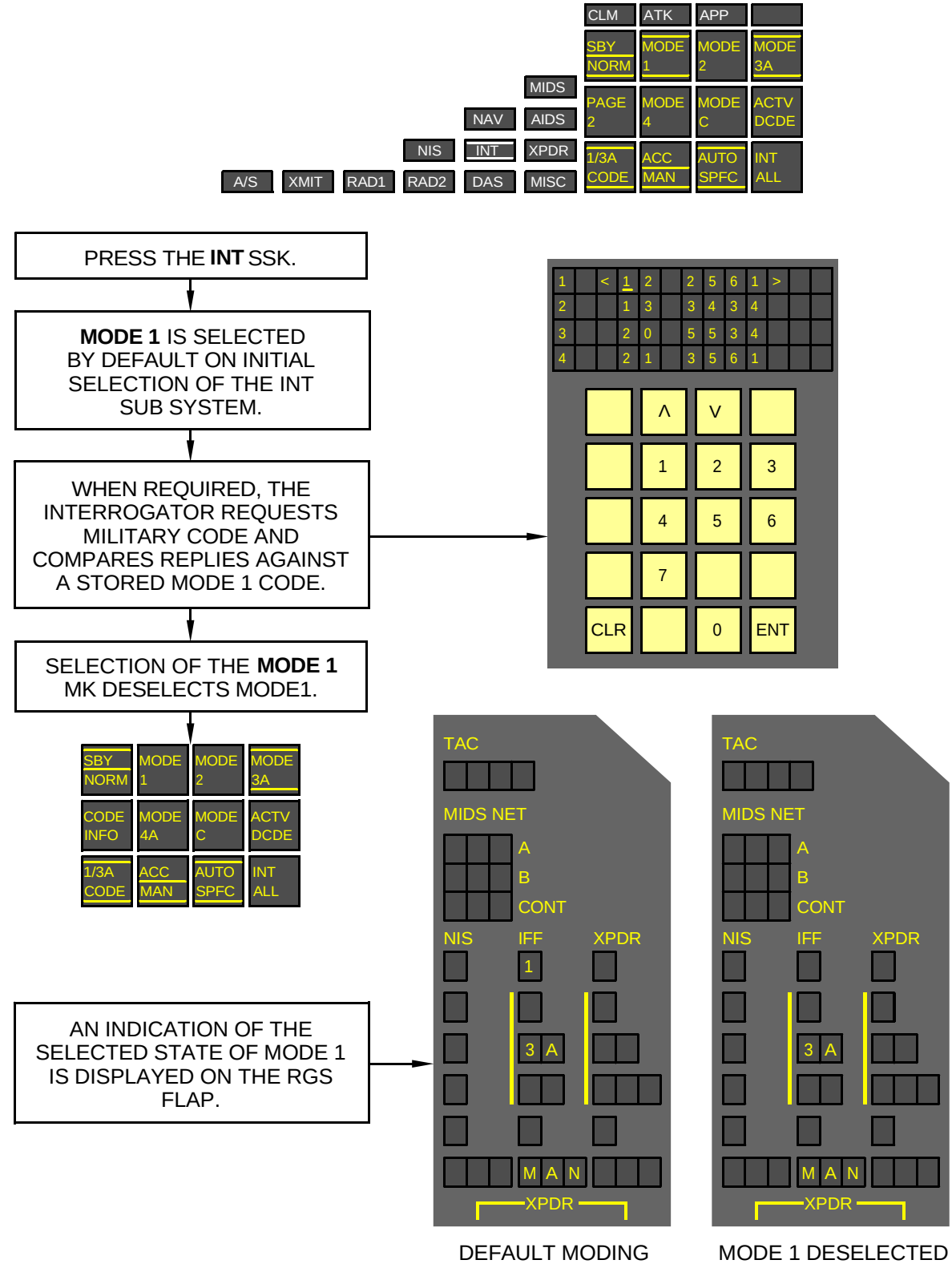


Figure 1.281 - INT Mode 1

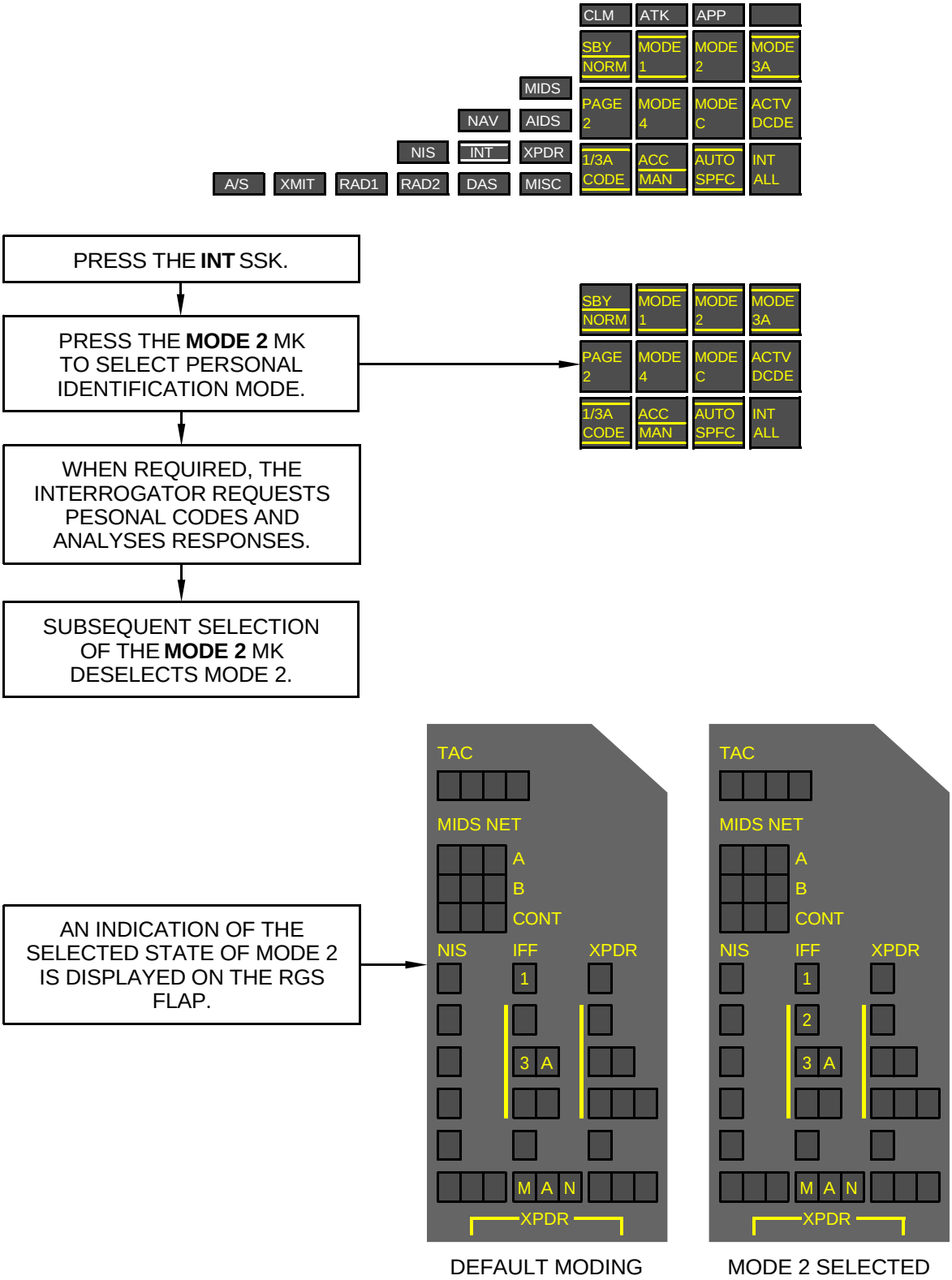


Figure 1.282 - INT Mode 2

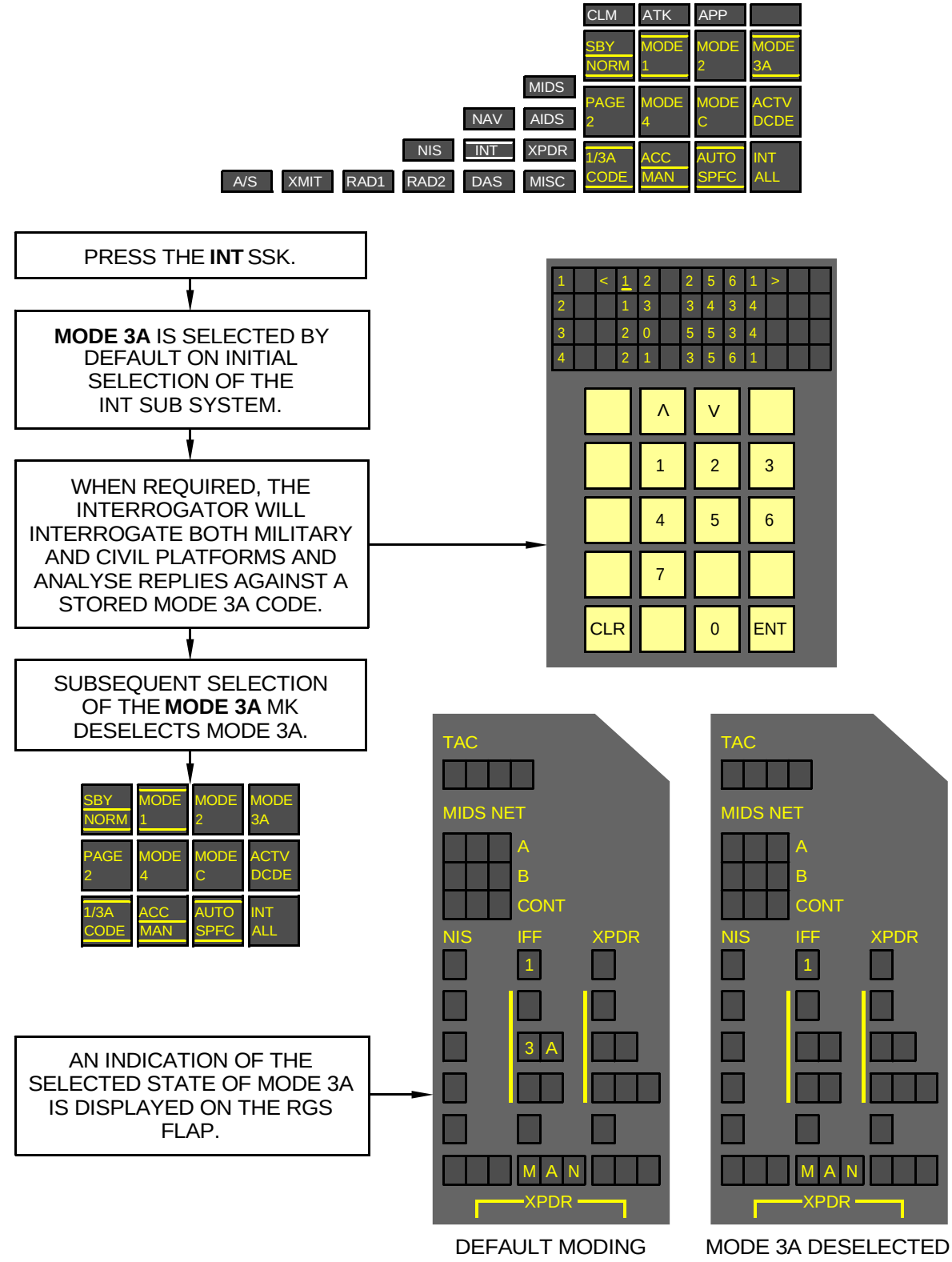


Figure 1.283 - INT Mode 3A

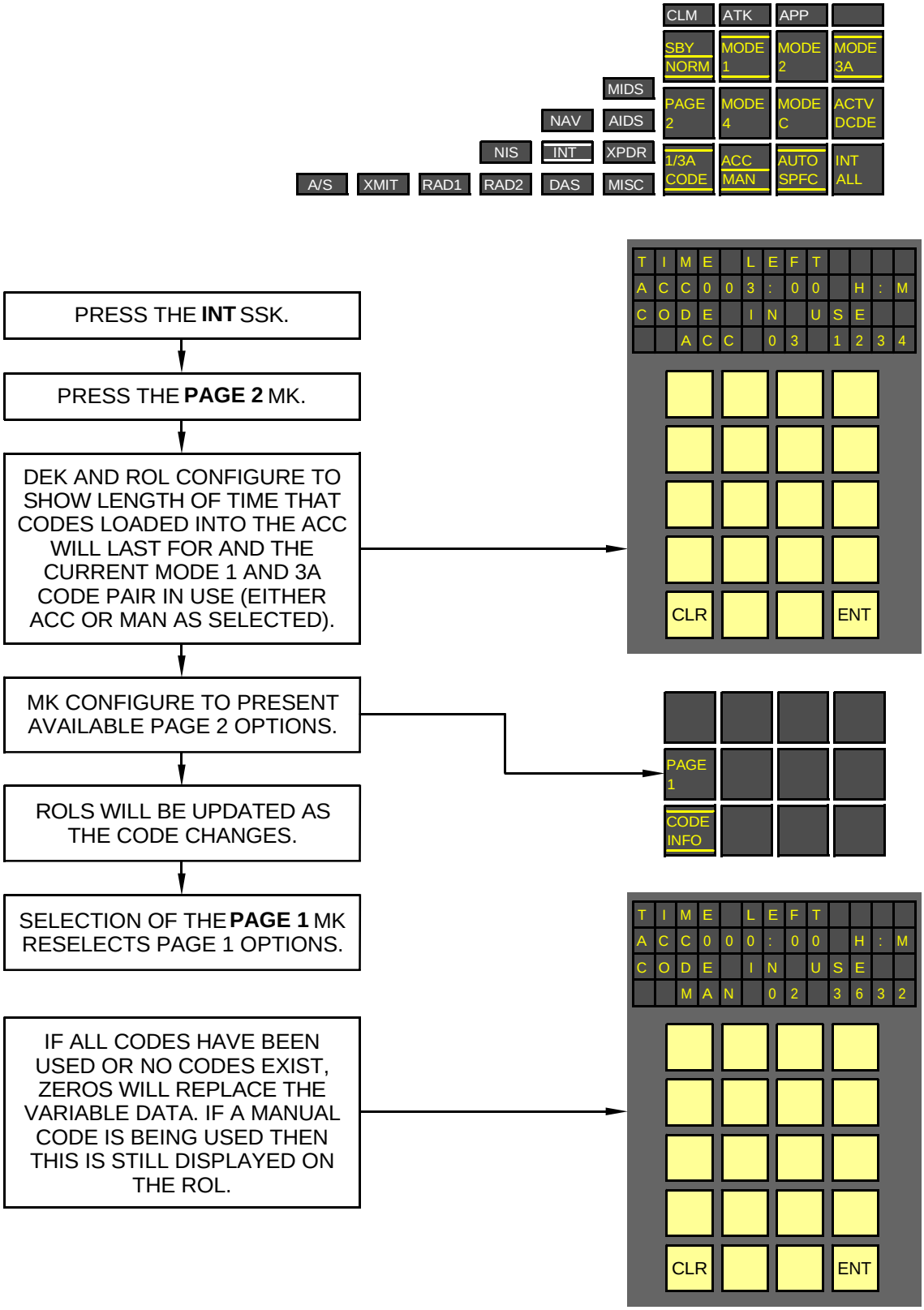


Figure 1.284 - INT Code Info (Page 2)

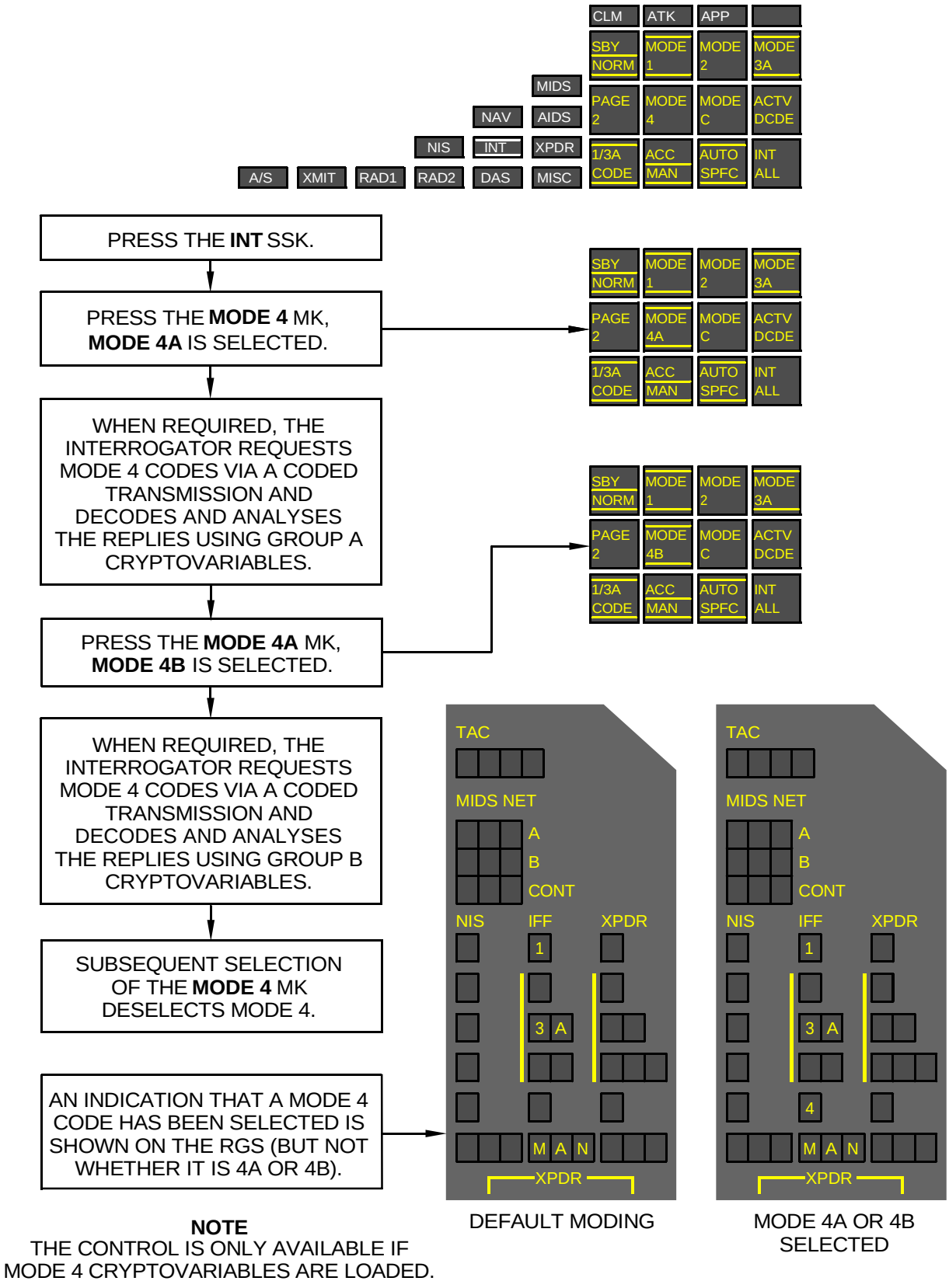


Figure 1.285 - INT Mode 4

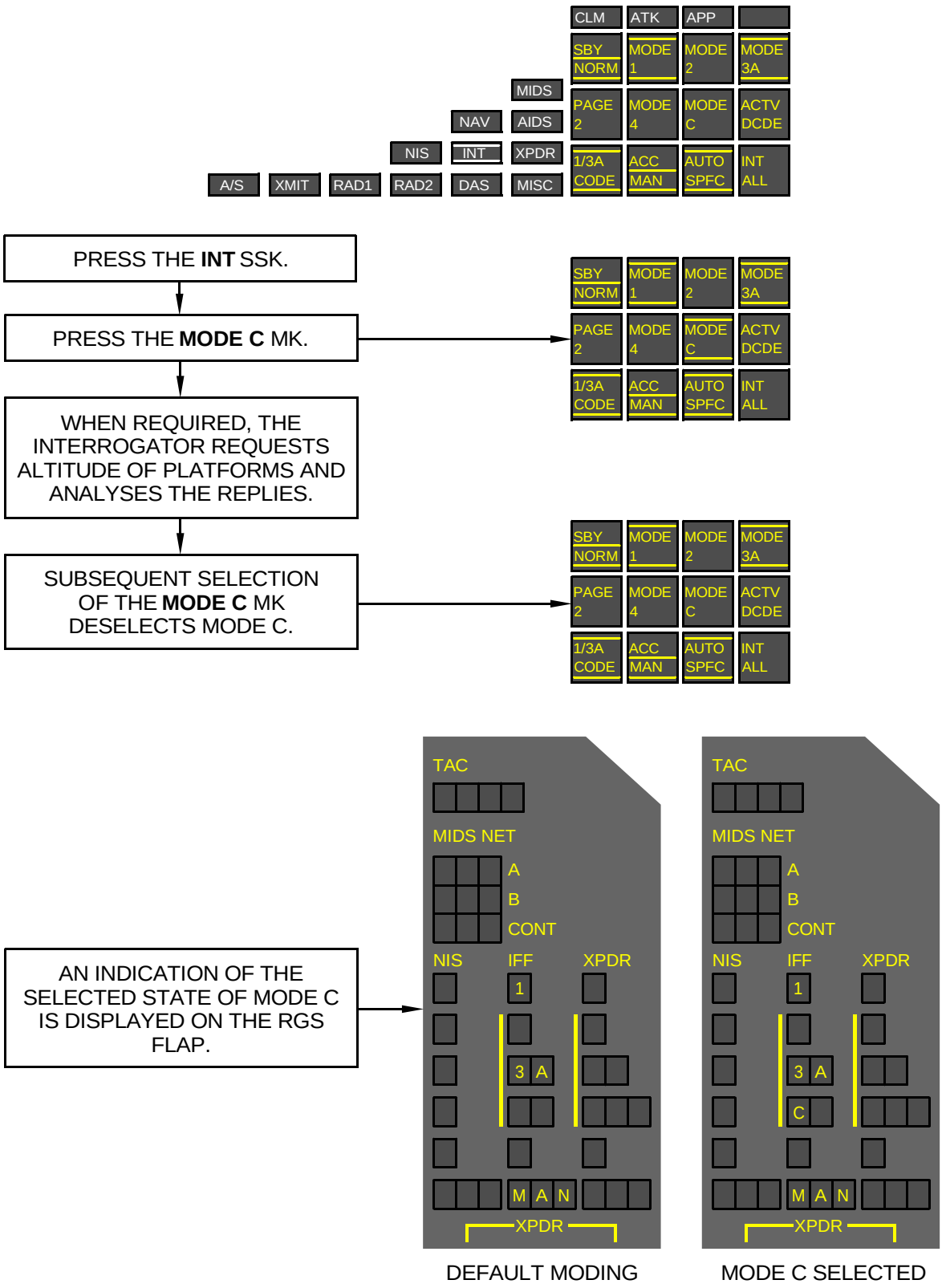
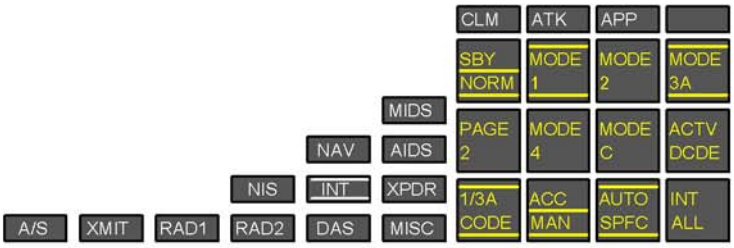


Figure 1.286 - INT Mode C



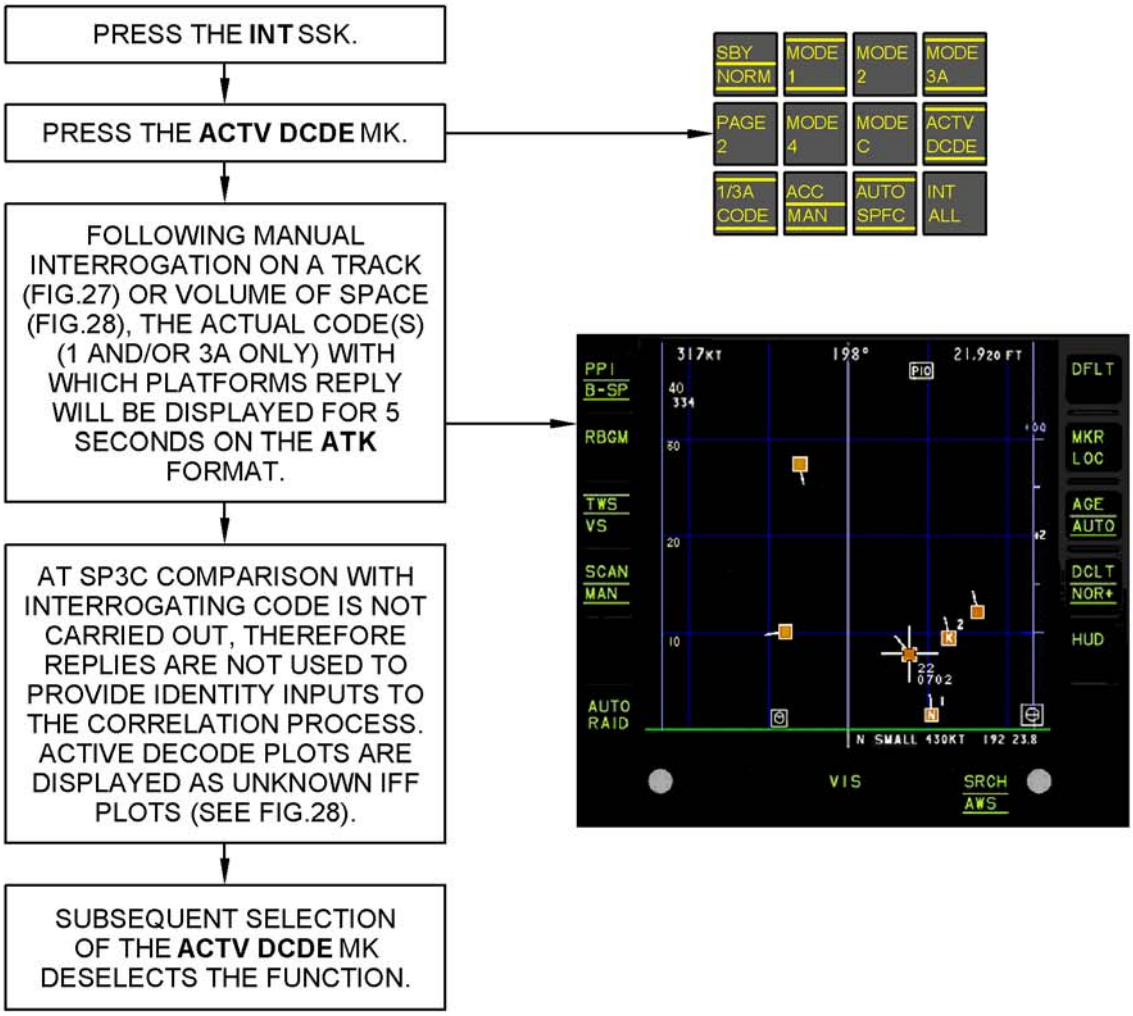

PRESS THE **INT** SSK.
PRESS THE **ACTV DCDE** MK.
FOLLOWING MANUAL INTERROGATION ON A TRACK (FIG.27) OR VOLUME OF SPACE (FIG.28), THE ACTUAL CODE(S) (1 AND/OR 3A ONLY) WITH WHICH PLATFORMS REPLY WILL BE DISPLAYED FOR 5 SECONDS ON THE **ATK** FORMAT.
AT SP3C COMPARISON WITH INTERROGATING CODE IS NOT CARRIED OUT, THEREFORE REPLIES ARE NOT USED TO PROVIDE IDENTITY INPUTS TO THE CORRELATION PROCESS. ACTIVE DECODE PLOTS ARE DISPLAYED AS UNKNOWN IFF PLOTS (SEE FIG.28).
SUBSEQUENT SELECTION OF THE **ACTV DCDE** MK DESELECTS THE FUNCTION.
SBY NORM
MODE 1
MODE 2
MODE 3A
PAGE 2
MODE 4
MODE C
ACTV DCDE
1/3A CODE
ACC MAN
AUTO SPFC
INT ALL
317KT
198°
21,920 FT
PPI B-SP
RBGM
TWS VS
SCAN MAN
AUTO RAID
DFLT
MKR LOC
AGE AUTO
DCLT NOR
HUD
N SMALL 430KT 192 23.8
VIS
SRCH AWS

Figure 1.287 - INT Active Decode

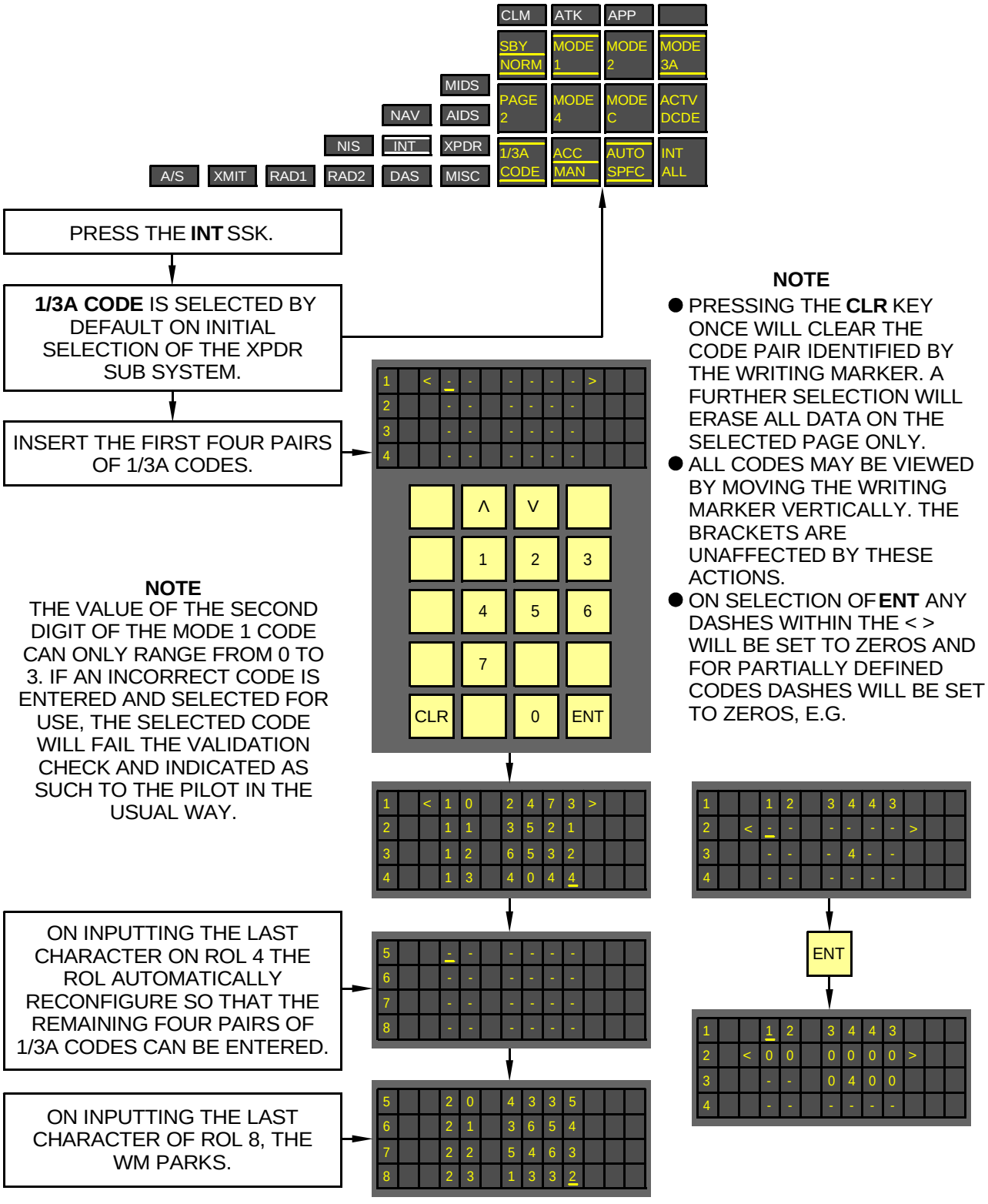

CLM
ATK
APP
SBY NORM
MODE 1
MODE 2
MODE 3A
MIDS
PAGE 2
MODE 4
MODE C
ACTV DCDE
NAV
AIDS
NIS
INT
XPDR
1/3A CODE
ACC MAN
AUTO SPFC
INT ALL
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE **INT** SSK.
1/3A CODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE XPDR SUB SYSTEM.
INSERT THE FIRST FOUR PAIRS OF 1/3A CODES.
ON INPUTTING THE LAST CHARACTER ON ROL 4 THE ROL AUTOMATICALLY RECONFIGURE SO THAT THE REMAINING FOUR PAIRS OF 1/3A CODES CAN BE ENTERED.
ON INPUTTING THE LAST CHARACTER OF ROL 8, THE WM PARKS.
NOTE
THE VALUE OF THE SECOND DIGIT OF THE MODE 1 CODE CAN ONLY RANGE FROM 0 TO 3. IF AN INCORRECT CODE IS ENTERED AND SELECTED FOR USE, THE SELECTED CODE WILL FAIL THE VALIDATION CHECK AND INDICATED AS SUCH TO THE PILOT IN THE USUAL WAY.
NOTE
● PRESSING THE **CLR** KEY ONCE WILL CLEAR THE CODE PAIR IDENTIFIED BY THE WRITING MARKER. A FURTHER SELECTION WILL ERASE ALL DATA ON THE SELECTED PAGE ONLY.
● ALL CODES MAY BE VIEWED BY MOVING THE WRITING MARKER VERTICALLY. THE BRACKETS ARE UNAFFECTED BY THESE ACTIONS.
● ON SELECTION OF **ENT** ANY DASHES WITHIN THE < > WILL BE SET TO ZEROS AND FOR PARTIALLY DEFINED CODES DASHES WILL BE SET TO ZEROS, E.G.
Λ
V
1
2
3
4
5
6
7
CLR
0
ENT

Figure 1.288 - INT 1/3A Manual Code Input

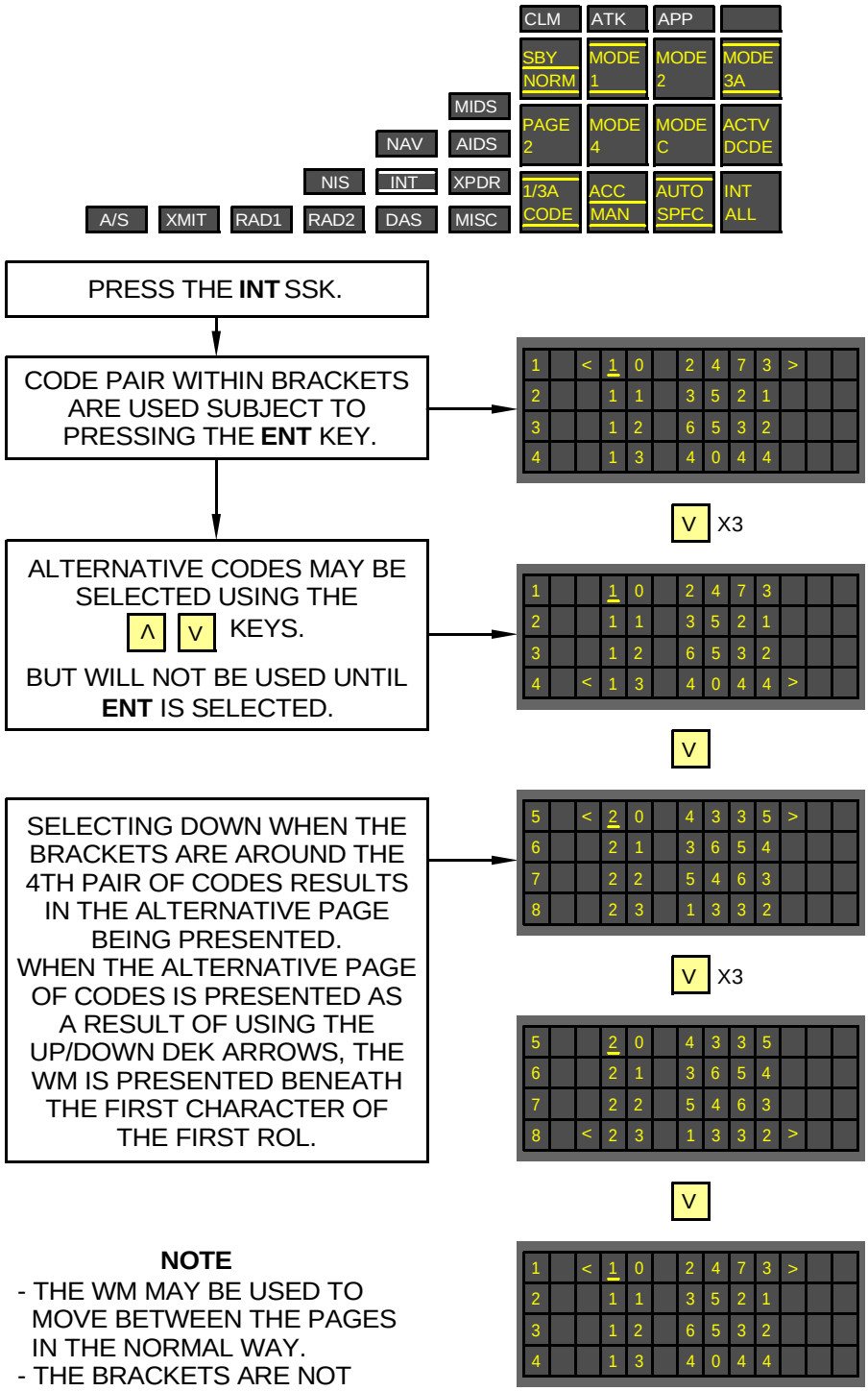

CLM
ATK
APP
SBY NORM
MODE 1
MODE 2
MODE 3A
MIDS
PAGE 2
MODE 4
MODE C
ACTV DCDE
NAV
AIDS
NIS
INT
XPDR
1/3A CODE
ACC MAN
AUTO SPFC
INT ALL
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE INT SSK.
CODE PAIR WITHIN BRACKETS ARE USED SUBJECT TO PRESSING THE ENT KEY.
V X3
ALTERNATIVE CODES MAY BE SELECTED USING THE ^ V KEYS.
BUT WILL NOT BE USED UNTIL ENT IS SELECTED.
V
SELECTING DOWN WHEN THE BRACKETS ARE AROUND THE 4TH PAIR OF CODES RESULTS IN THE ALTERNATIVE PAGE BEING PRESENTED.
WHEN THE ALTERNATIVE PAGE OF CODES IS PRESENTED AS A RESULT OF USING THE UP/DOWN DEK ARROWS, THE WM IS PRESENTED BENEATH THE FIRST CHARACTER OF THE FIRST ROL.
V X3
V
NOTE
- THE WM MAY BE USED TO MOVE BETWEEN THE PAGES IN THE NORMAL WAY.
- THE BRACKETS ARE NOT AFFECTED BY THE MOVEMENT OF THE WM.
- THE WM WILL ALWAYS BE SHOWN ON THE ROL PAGE IN VIEW, WHEREAS THE BRACKETS MAY NOT.

Figure 1.289 - INT 1/3A Manual Code - Selection of Codes

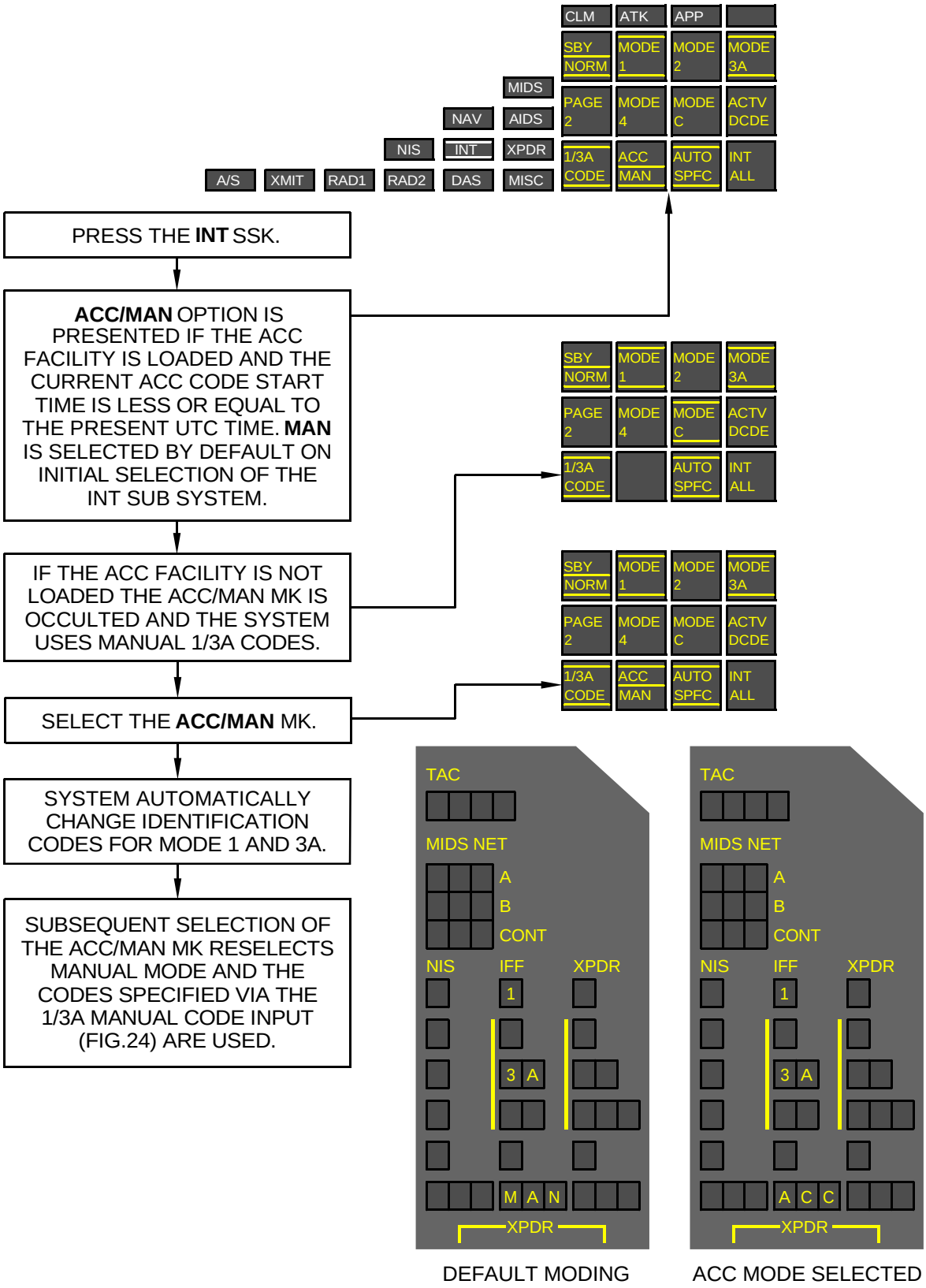


Figure 1.290 - INT ACC/MAN Code Selection

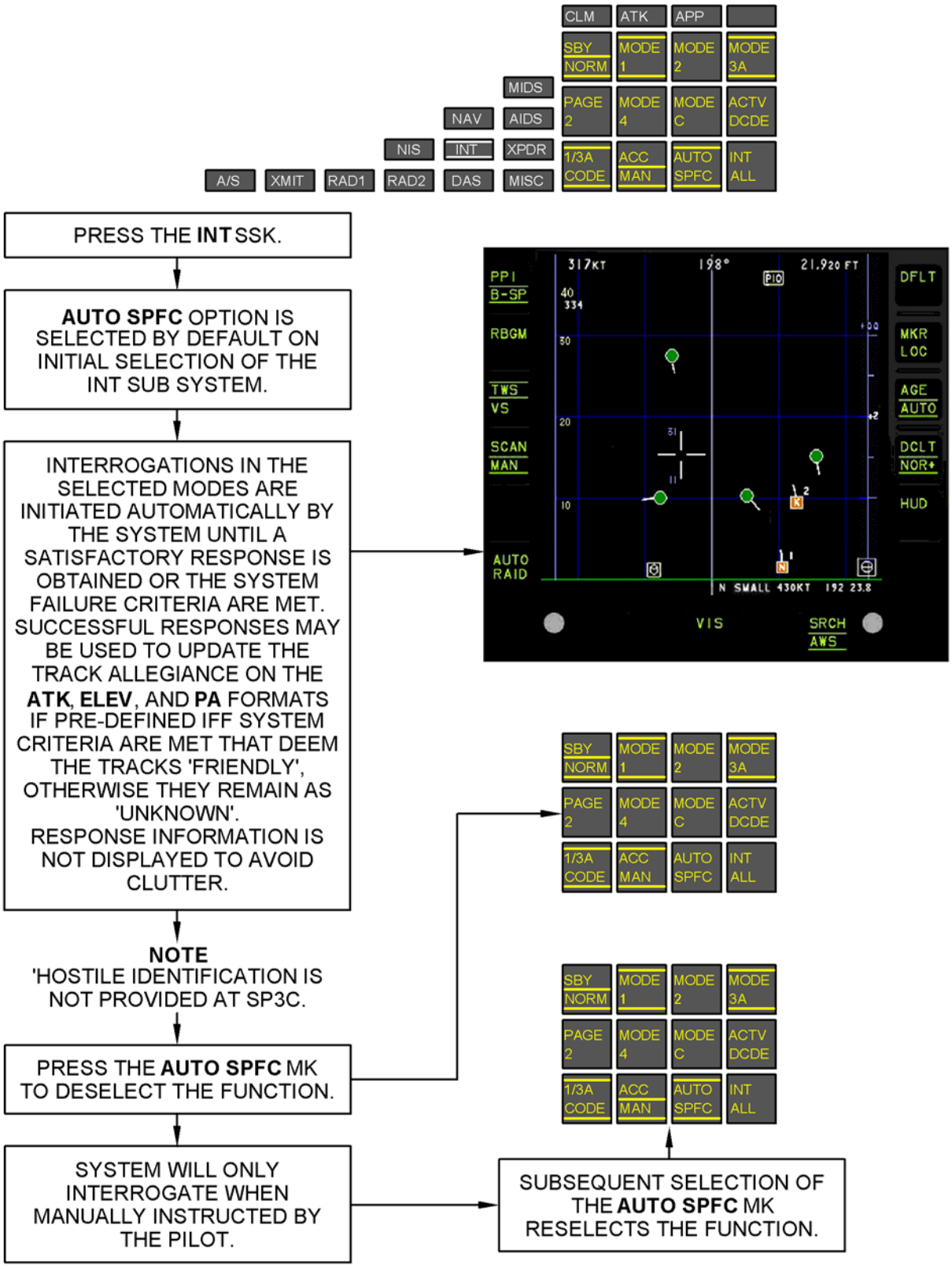


Figure 1.291 - INT Auto Specific Operation

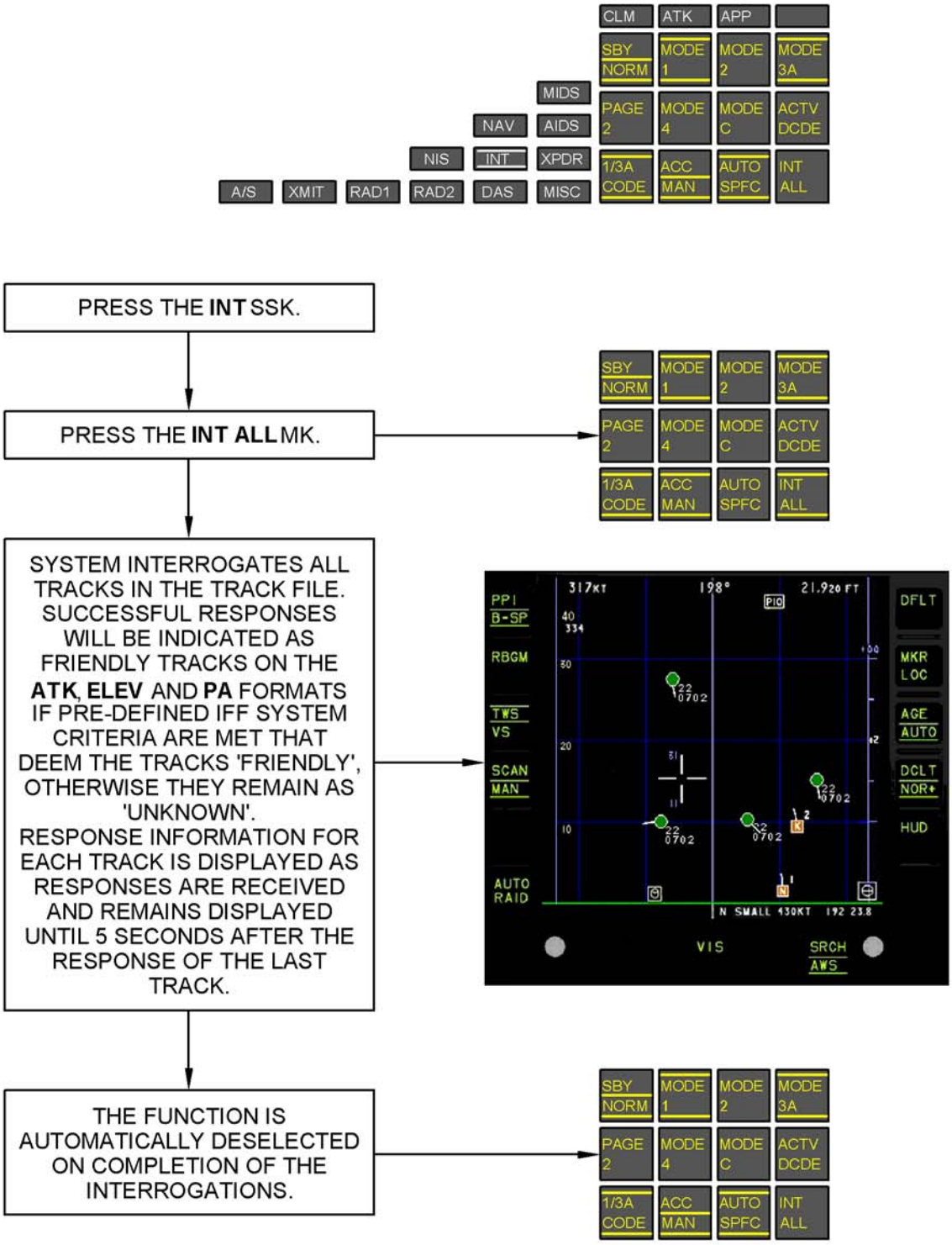
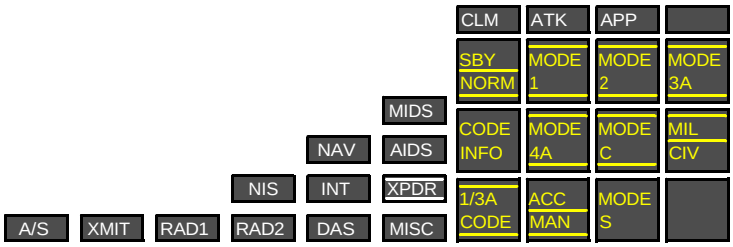


Figure 1.292 - Interrogate All



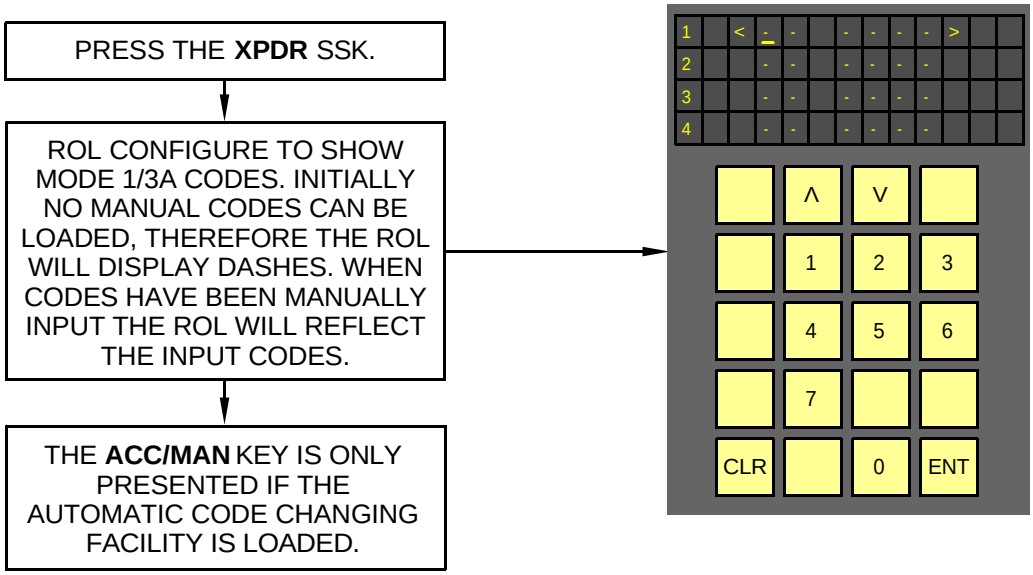


Figure 1.293 - Default Moding of the XPDR SS

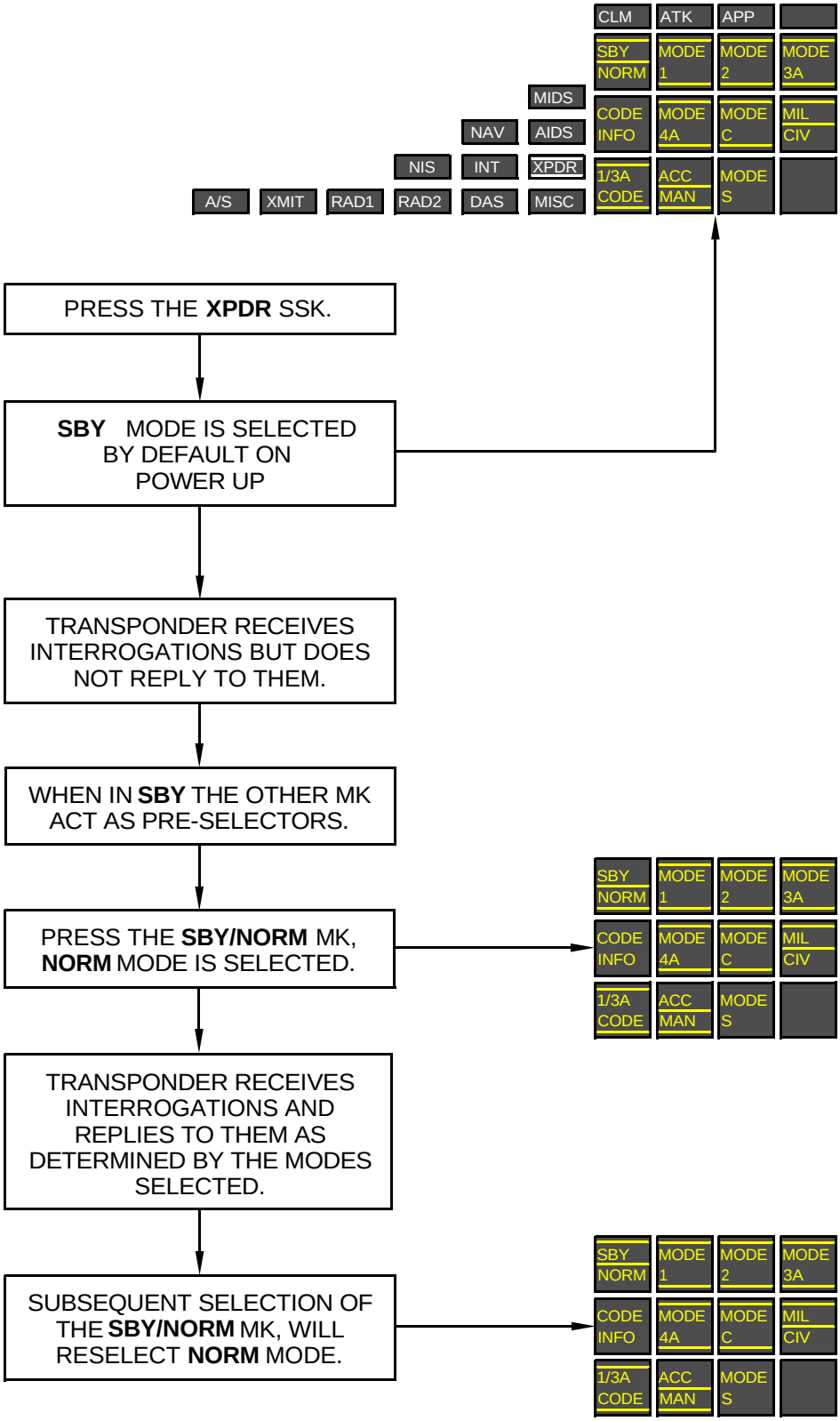


Figure 1.294 - XPDR Standby/Normal Mode Selection

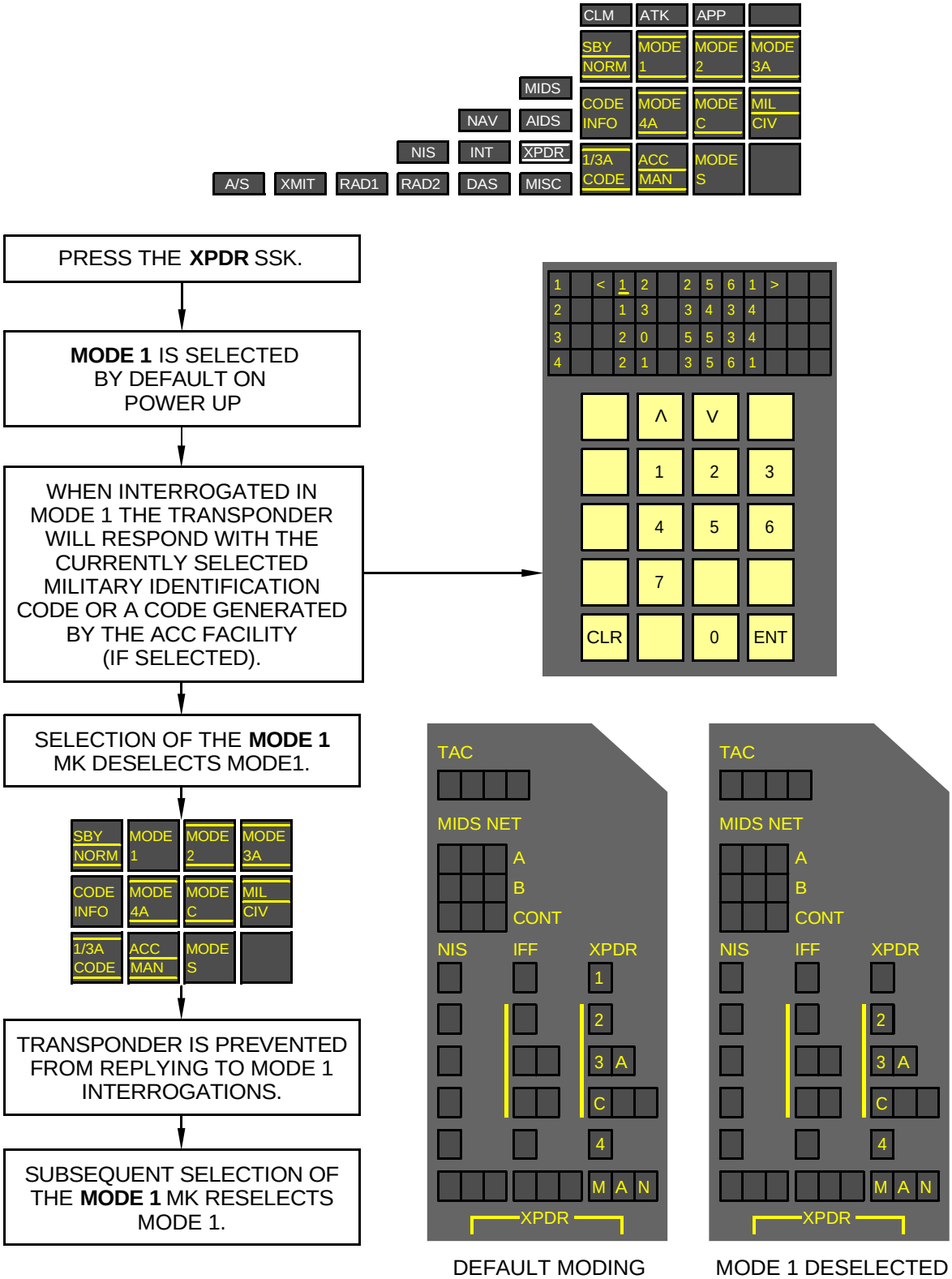
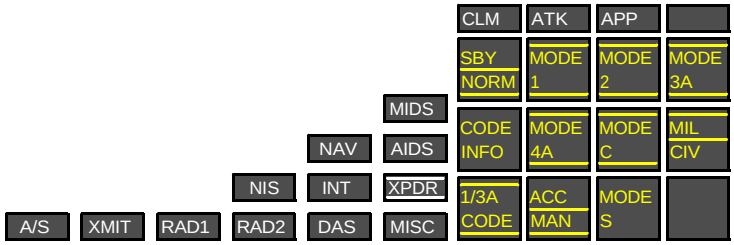


Figure 1.295 - XPDR Mode 1



PRESS THE **XPDR** SSK.

MODE 2 IS SELECTED BY DEFAULT ON POWER UP

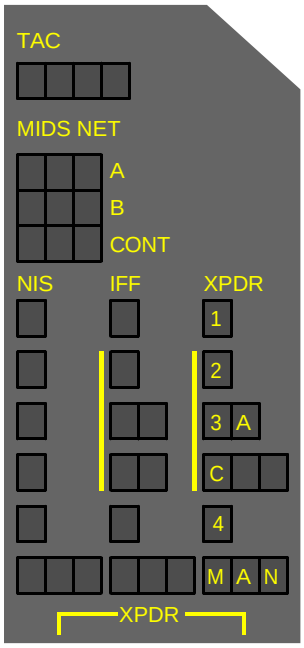
WHEN INTERROGATED IN MODE 2 THE TRANSPONDER WILL RESPOND WITH THE AIRCRAFTS PERSONAL IDENTIFICATION CODE.

SELECTION OF THE **MODE 2** MK DESELECTS MODE 2.

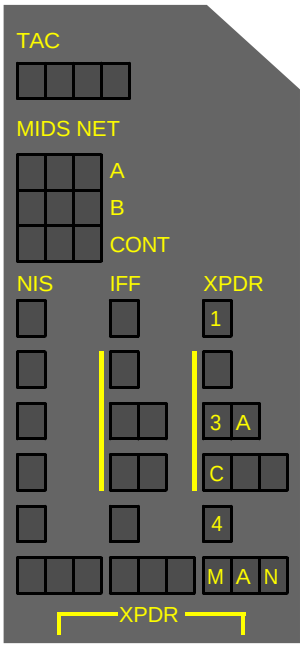
TRANSPONDER IS PREVENTED FROM REPLYING TO MODE 2 INTERROGATIONS

SUBSEQUENT SELECTION OF THE **MODE 2** MK RESELECTS MODE 2.

NOTE
MODE 2 IS LOADED INTO THE SYSTEM BY THE GROUNDCREW. IT CANNOT BE ENTERED OR ALTERED BY THE AIRCREW.



DEFAULT MODING



MODE 2 DESELECTED

Figure 1.296 - XPDR Mode 2

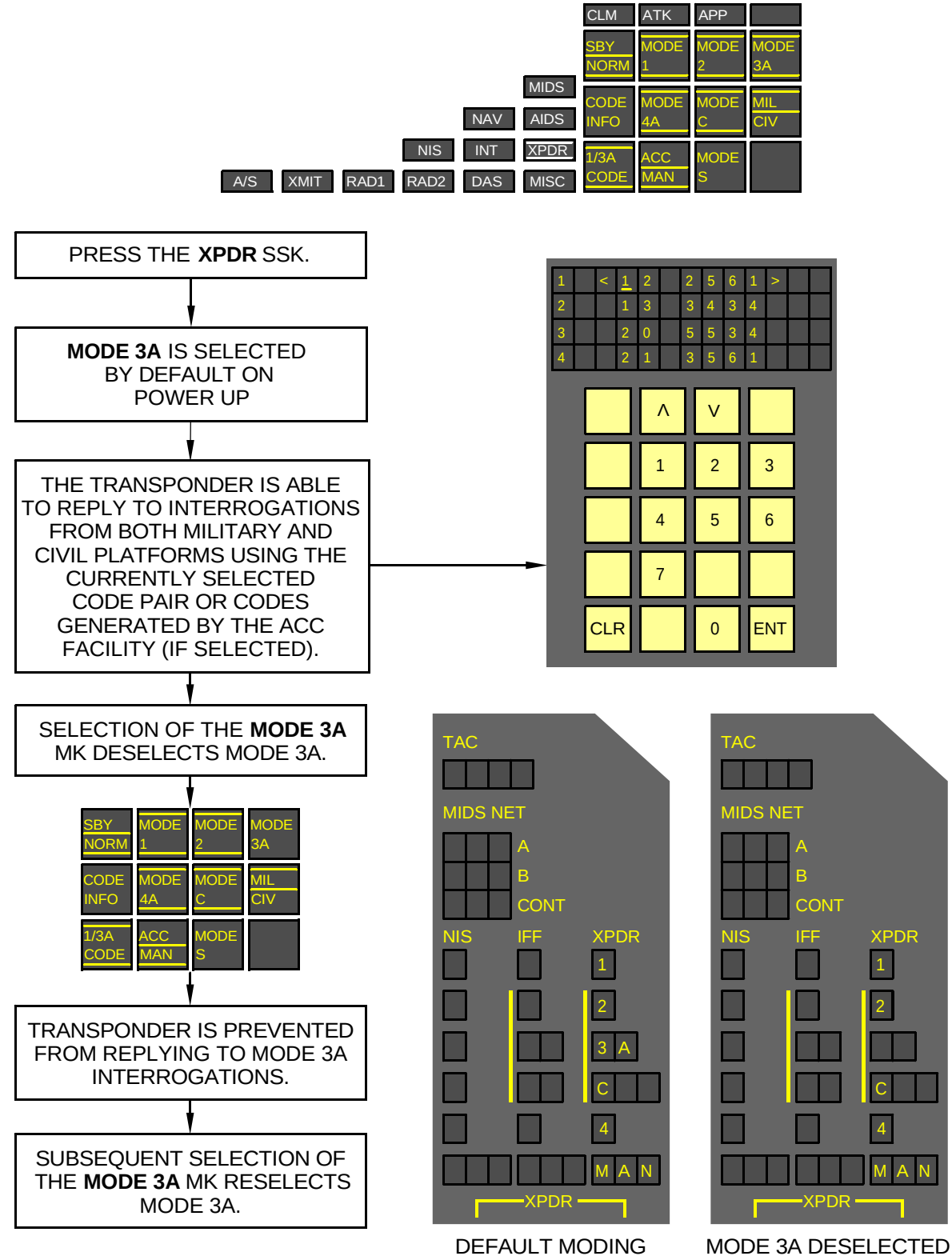


Figure 1.297 - XPDR Mode 3A

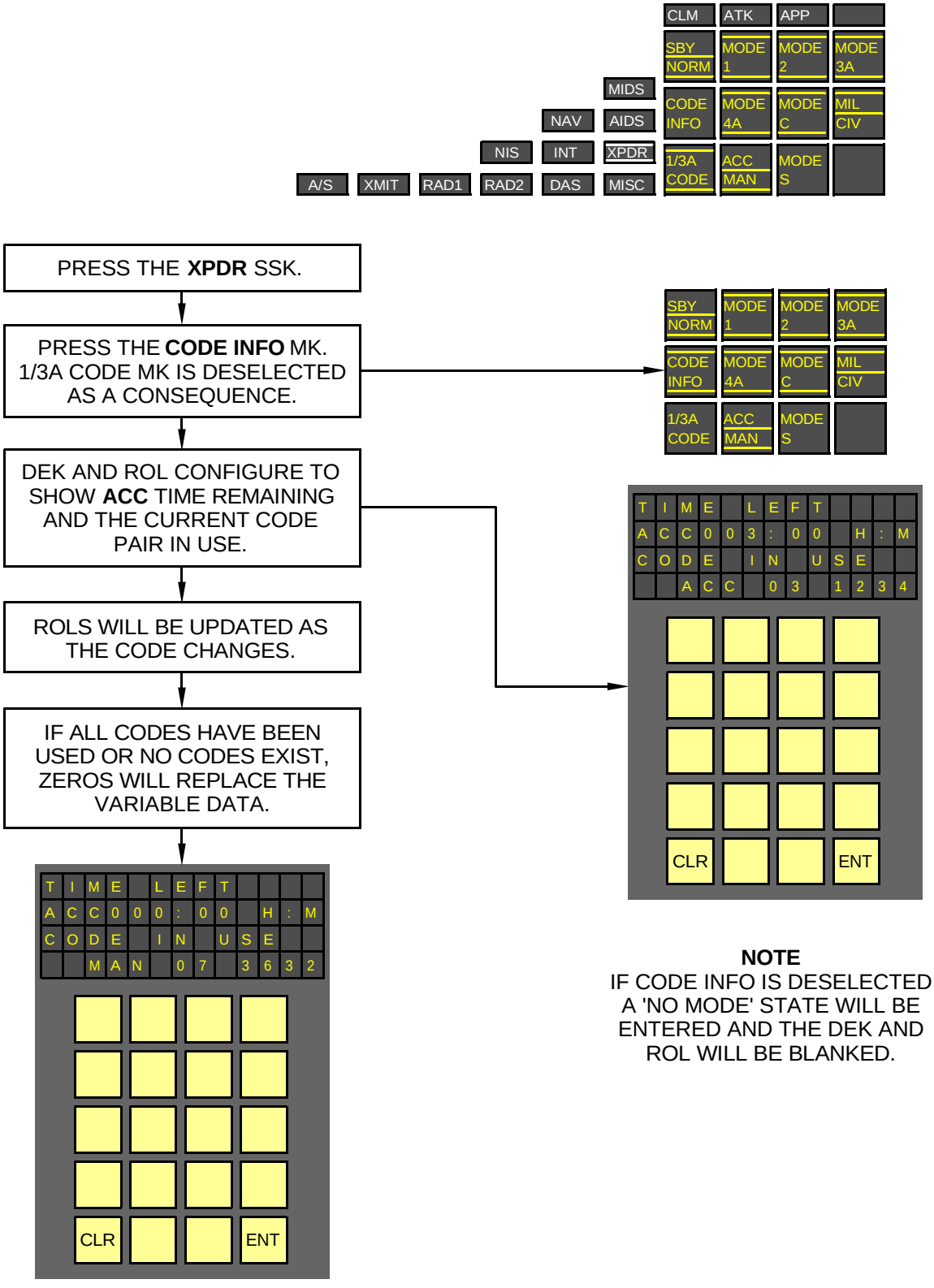


Figure 1.298 - XPDR Code Info

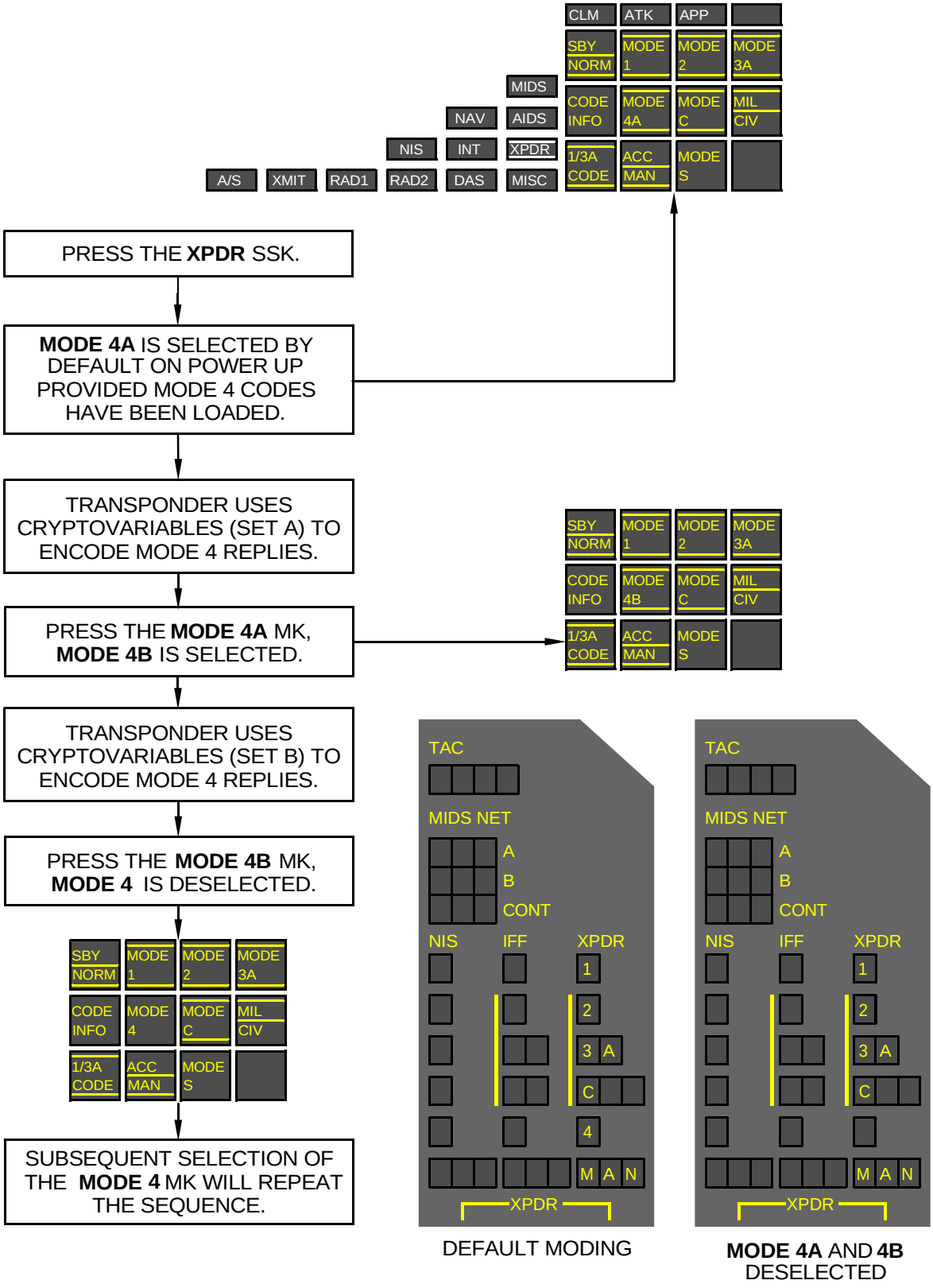


Figure 1.299 - XPDR Mode 4

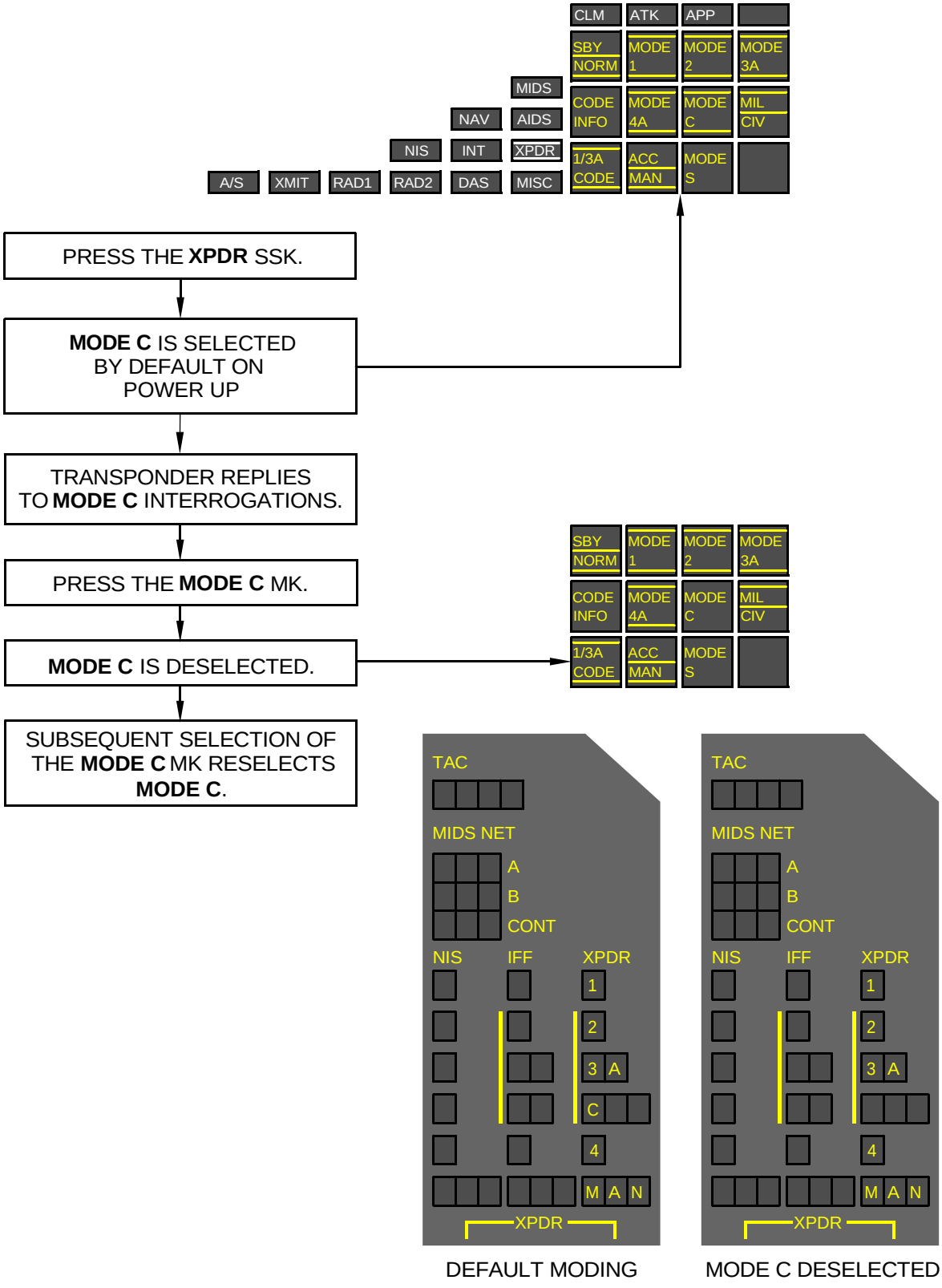


Figure 1.300 - XPDR Mode C

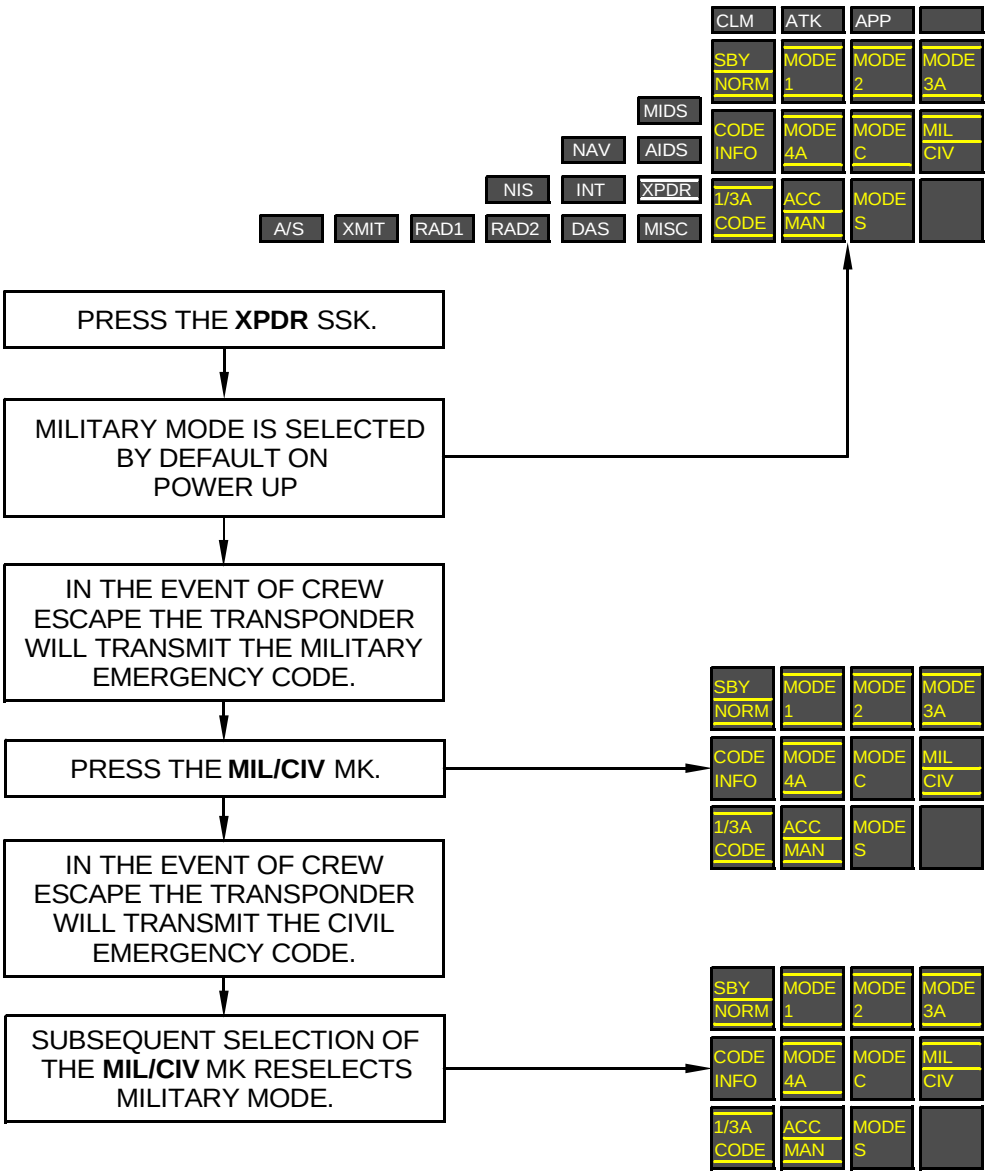


Figure 1.301 - XPDR MIL/CIV Mode Operation

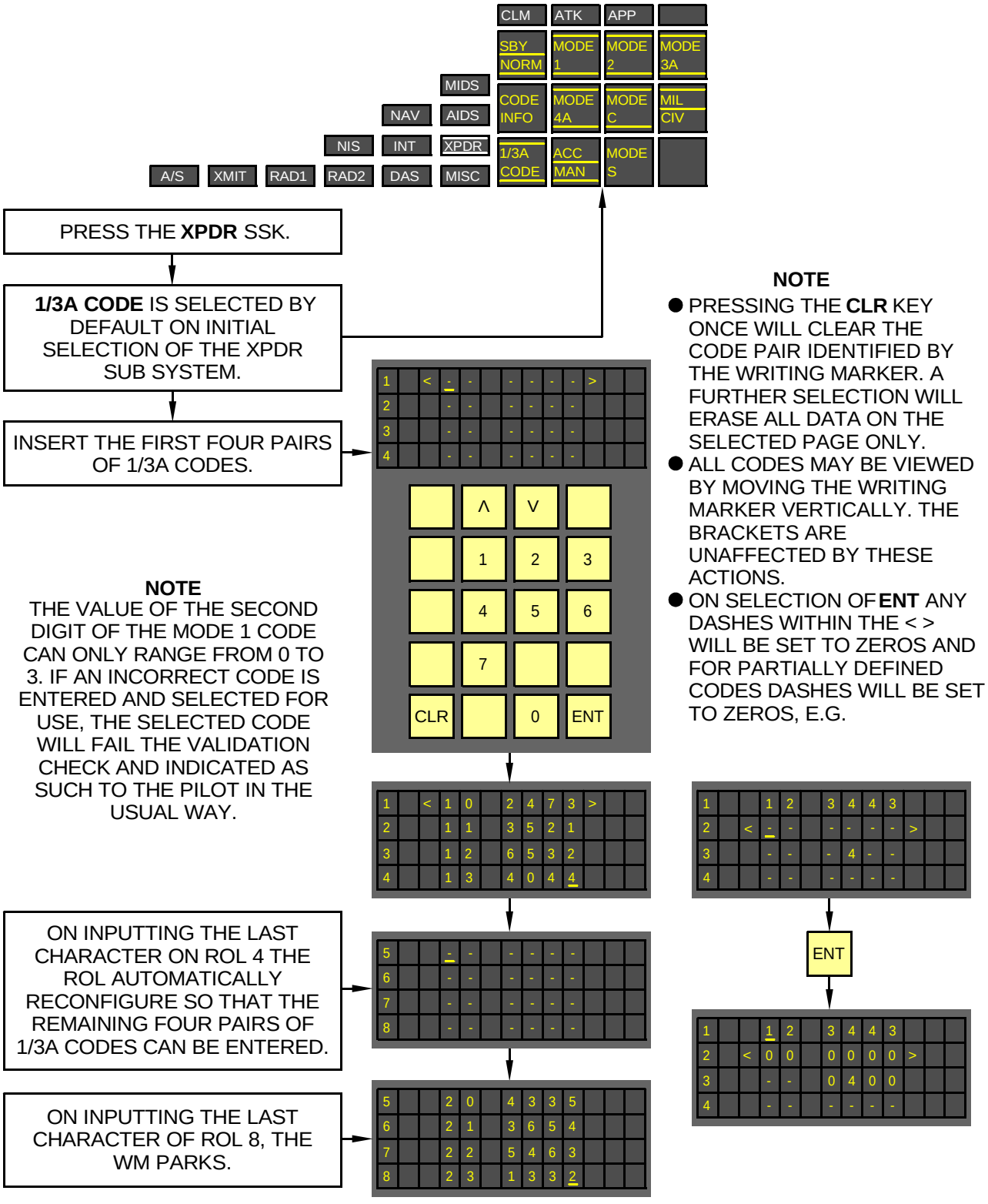

CLM
ATK
APP
SBY NORM
MODE 1
MODE 2
MODE 3A
MIDS
CODE INFO
MODE 4A
MODE C
MIL CIV
NAV
AIDS
NIS
INT
XPDR
1/3A CODE
ACC MAN
MODE S
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE **XPDR** SSK.
1/3A CODE IS SELECTED BY DEFAULT ON INITIAL SELECTION OF THE XPDR SUB SYSTEM.
INSERT THE FIRST FOUR PAIRS OF 1/3A CODES.
Λ
V
1
2
3
4
5
6
7
CLR
0
ENT
NOTE
THE VALUE OF THE SECOND DIGIT OF THE MODE 1 CODE CAN ONLY RANGE FROM 0 TO 3. IF AN INCORRECT CODE IS ENTERED AND SELECTED FOR USE, THE SELECTED CODE WILL FAIL THE VALIDATION CHECK AND INDICATED AS SUCH TO THE PILOT IN THE USUAL WAY.
ON INPUTTING THE LAST CHARACTER ON ROL 4 THE ROL AUTOMATICALLY RECONFIGURE SO THAT THE REMAINING FOUR PAIRS OF 1/3A CODES CAN BE ENTERED.
ON INPUTTING THE LAST CHARACTER OF ROL 8, THE WM PARKS.
NOTE
- PRESSING THE **CLR** KEY ONCE WILL CLEAR THE CODE PAIR IDENTIFIED BY THE WRITING MARKER. A FURTHER SELECTION WILL ERASE ALL DATA ON THE SELECTED PAGE ONLY.
- ALL CODES MAY BE VIEWED BY MOVING THE WRITING MARKER VERTICALLY. THE BRACKETS ARE UNAFFECTED BY THESE ACTIONS.
- ON SELECTION OF **ENT** ANY DASHES WITHIN THE < > WILL BE SET TO ZEROS AND FOR PARTIALLY DEFINED CODES DASHES WILL BE SET TO ZEROS, E.G.
ENT

Figure 1.302 - XPDR 1/3A Manual Code Input

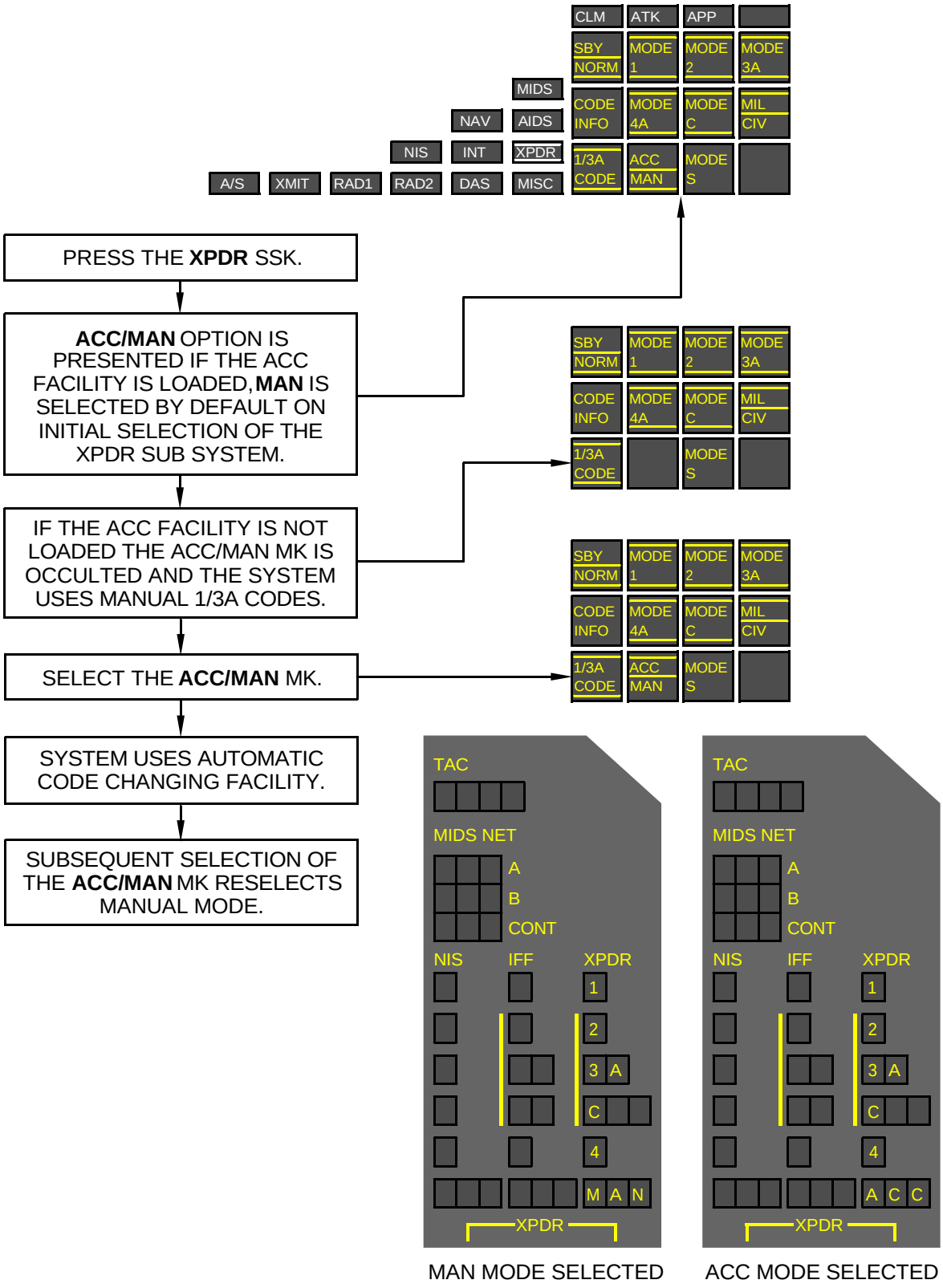


Figure 1.303 - XPDR 1/3A Manual Code - Selection of Codes

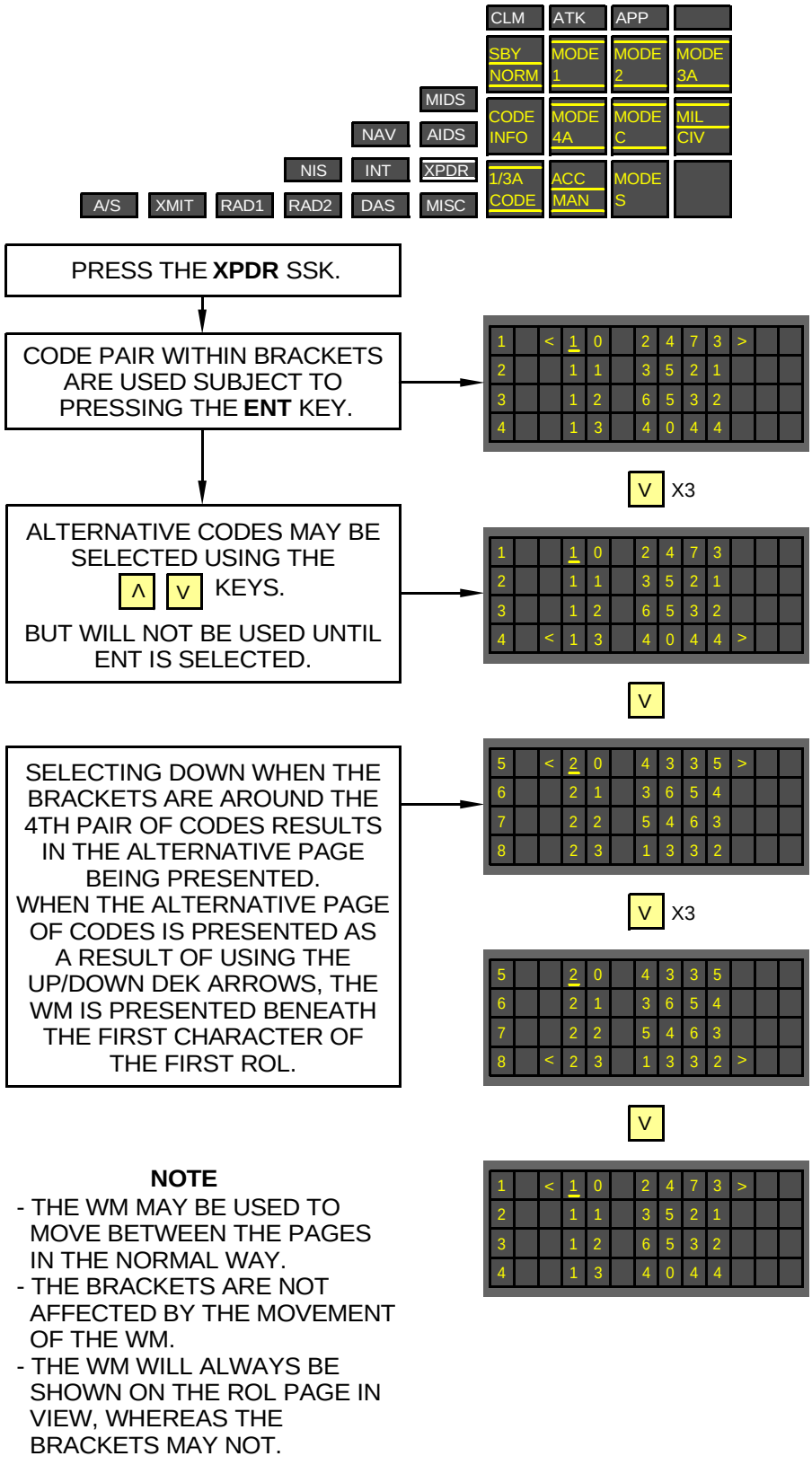

CLM
ATK
APP
SBY NORM
MODE 1
MODE 2
MODE 3A
MIDS
CODE INFO
MODE 4A
MODE C
MIL CIV
NAV
AIDS
NIS
INT
XPDR
1/3A CODE
ACC MAN
MODE S
A/S
XMIT
RAD1
RAD2
DAS
MISC
PRESS THE **XPDR** SSK.
CODE PAIR WITHIN BRACKETS ARE USED SUBJECT TO PRESSING THE **ENT** KEY.
ALTERNATIVE CODES MAY BE SELECTED USING THE Λ V KEYS.
BUT WILL NOT BE USED UNTIL ENT IS SELECTED.
SELECTING DOWN WHEN THE BRACKETS ARE AROUND THE 4TH PAIR OF CODES RESULTS IN THE ALTERNATIVE PAGE BEING PRESENTED.
WHEN THE ALTERNATIVE PAGE OF CODES IS PRESENTED AS A RESULT OF USING THE UP/DOWN DEK ARROWS, THE WM IS PRESENTED BENEATH THE FIRST CHARACTER OF THE FIRST ROL.
V X3
V
V X3
V
NOTE
- THE WM MAY BE USED TO MOVE BETWEEN THE PAGES IN THE NORMAL WAY.
- THE BRACKETS ARE NOT AFFECTED BY THE MOVEMENT OF THE WM.
- THE WM WILL ALWAYS BE SHOWN ON THE ROL PAGE IN VIEW, WHEREAS THE BRACKETS MAY NOT.

Figure 1.304 - XPDR ACC/MAN Code Selection

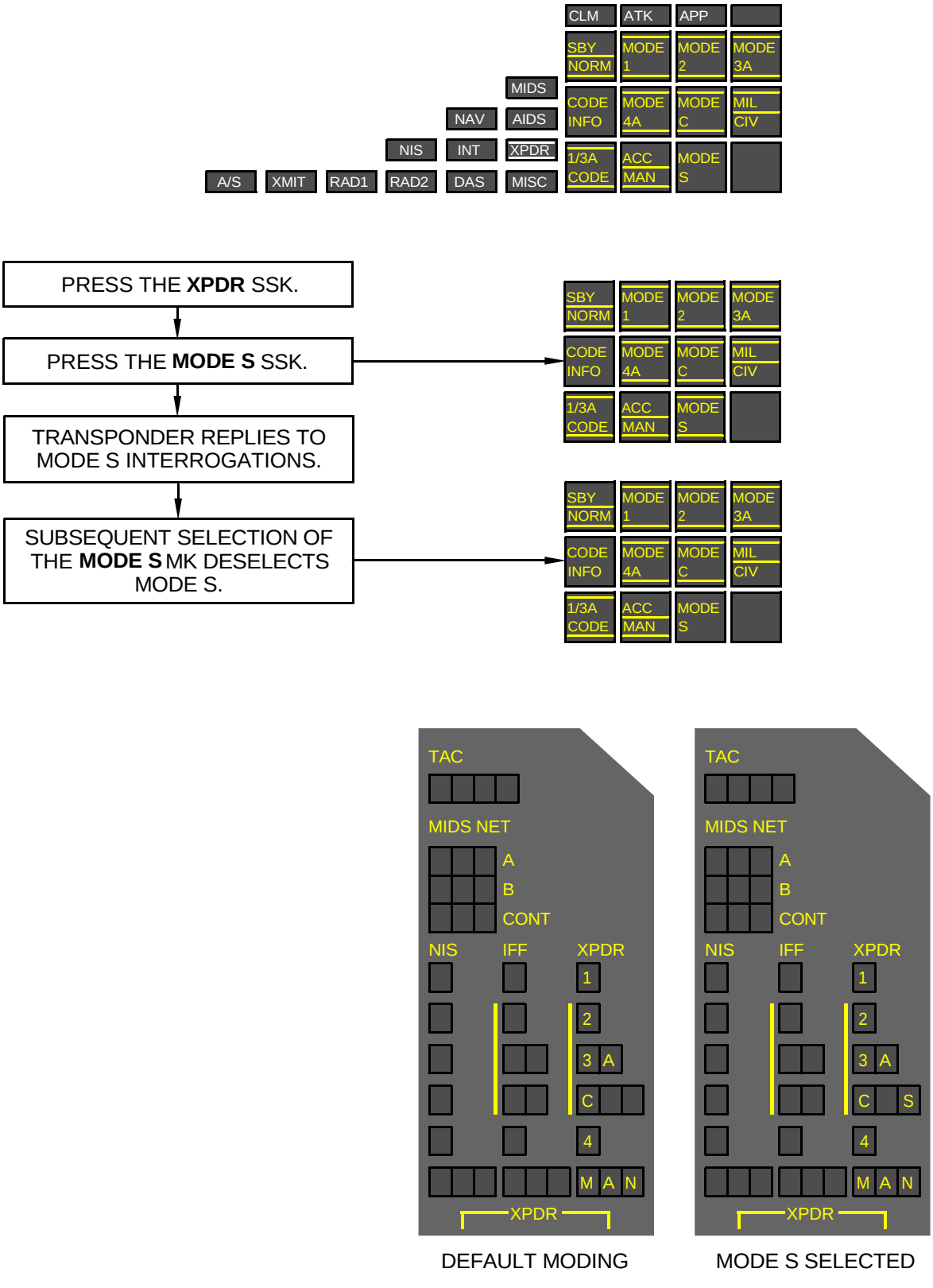
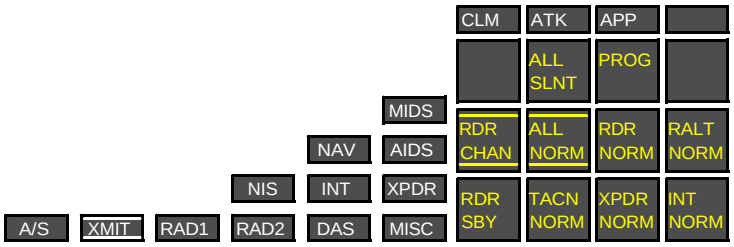


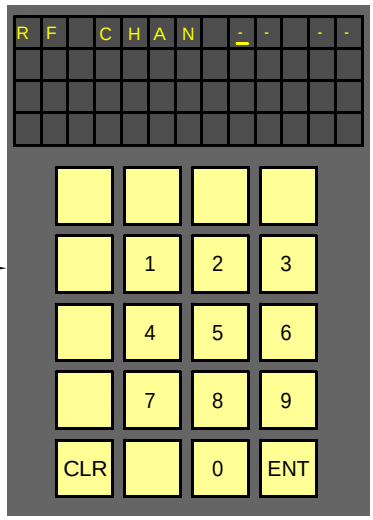
Figure 1.305 - XPDR Mode S - ATC Mode



PRESS THE **XMIT** SSK.

RDR SBY SHOWN BY DEFAULT ON POWER UP IF RADAR IS SWITCHED ON AND HAS PASSED PBIT.
IN SBY MODE THE RADAR'S TRANSMITTER AND RECEIVER ARE INHIBITED.

DEK AND ROL CONFIGURE TO ENABLE A PAIR OF RADAR CHANNEL NUMBERS TO BE ENTERED OR TO DISPLAY THE CURRENT CHANNEL PAIR AS NECESSARY.



NOTE
THE PRESELECTIONS FOR THE INDIVIDUAL TRANSMITTERS DEFAULT TO NORM, BUT CAN BE MODIFIED THROUGH A PDS LOAD

Figure 1.306 - Default Moding of the XMIT SS

DEFENSIVE AIDS SUBSYSTEM

Defensive Aids Subsystem

(1B-B-99-00-00-00A-043A-A Issue 004)

Introduction

DASS is an integrated self-defense system that senses threats to the aircraft, from radar emitters, passive and active missiles, and laser emitters. The system then automatically applies the appropriate countermeasure with minimal pilot involvement.

The complete suite of the Defensive Aids Subsystem (DASS) will be available at PSP2. However, at PSP1 the DASS is restricted to a limited chaff and flare capability, enabling the manual release of expendables via HOTAS. This will allow for the rapid release of chaff only, or chaff and flare programs, as well as the release of expendables for tactical support. These functions will be co-ordinated by the software in the Defensive Aids Computer (DAC).

The DASS uses onboard and towed decoy jamming/ deception electronic countermeasures, chaff, flares and may request aircraft maneuvers to counter threats. It also contributes when in the attack role by detecting and identifying target platforms/emitters.

Control of DASS operation, via the Defensive Aids (DA) bus, and processing of sensor data is performed by the DAC using the mission data loaded for the sortie. Mission data includes a library of known emitter signal parameters for identification, signal search strategies, frequency bands to be monitored and threat level values for determining countermeasure priority. If analysis of a threat signal cannot identify the source emitter/platform a default countermeasure is carried out and the signal data is recorded for further analysis by specialist personnel.

Only chaff and flare dispense programs can be loaded, via the Portable Data Store (PDS) to the system, two of these programs can be modified using the Manual Data Entry Facility (MDEF). The left and right chaff launchers are located on the integrated tip stub pylons whilst the flares are installed on the left and right Inboard flapperon actuator fairings, refer to Figure 1.307. The DASS can be programed to release chaff, flare, or a combination of both chaff and flare. The release of expendables is programmed either via the PDS or via MDEF on the left glareshield.

For additional information of controls, indicators and displays, refer to:

– Defensive Aids Subsystem pag. 1-588
– Defensive Aids Subsystem pag. 1-585.

DASS Subsystems

The DASS comprises the following subsystems, refer to Figure 1.307 :

– Defensive Aids Computer (DAC)
– Chaff and flare dispensers
– Electronic Countermeasure/Electronic Support Measures (ECM/ESM) (not yet available)
– Missile Approach Warner (MAW) (not yet available)
– Laser Warner (LW) (not yet available).

Defensive Aids Computer

The DAC coordinates and controls all DASS functions. It correlates data from all available sensors and determines the best available countermeasure to adopt. The DAC also processes manually input DASS data, e.g. pilot initiated chaff and flare dispense programs.

Interoperability of all onboard emitters and receivers are managed by the DAC, it also provides the transmission suppression stealth management function. All onboard emitters can be suppressed simultaneously or independently to meet the aircraft stealth requirements specified in the mission data. The DAC is the primary controller for the DA bus, used for data transfer between DASS equipment, and it is also the secondary controller for the attack bus.

For additional information, refer to Defensive Aids Computer pag. 1-584.

Chaff and Flare capability at PSP1

Chaff and flares are manually dispensed by using the expendables release manual control on the left rear console. When selected to the MAN position expendables are dispensed using the chaff/flare release switch on the left throttle top.

Dependent on the position of the expendables release manual control, forward movement of the chaff/flare release switch will result in the release of the default chaff program or expendables program if selected from the MDEF. Aft movement of the switch will initiate the release of the default chaff/flare program.

Chaff/flare release is dependent on the availability of the chaff/flares dispense functionality and the setting of certain interlocks i.e. Master Armament Safety Switch (MASS) set to LIVE and expendables release manual control set to either EXPD or MAN.

Chaff and Flare capability at PSP2

Chaff and flares can be dispensed automatically by the DAC or the MAW, or manually dispensed by using the expendables release manual control on the left rear console. When selected to the MAN position

expendables are dispensed using the chaff/flare release switch on the left throttle top.

Dependent on the position of the expendables release manual control, forward movement of the chaff/flare release switch will result in the release of the default chaff program or expendables program if selected from the MDEF. Aft movement of the switch will initiate the release of the default chaff/flare program.

Chaff/flare release is dependent on the availability of the chaff/flares dispense functionality and the setting of certain interlocks i.e. Master Armament Safety Switch (MASS) set to LIVE and expendables release manual control set to either EXPD or MAN.

Electronic Countermeasures (Not yet available)

The ECM system supplies signal jamming/deception in the radio frequency (RF) ranges specified by the DAC. ECM is generated using emitters in the front and rear of the left wing tip pod or a towed decoy array located in the rear right wing tip pod. There are two towed decoy arrays although only one decoy may be towed at any time. Decoy retraction is not possible, and therefore must be discarded after use by using the CUT selection on the decoy deployment switch.

Electronic Support Measures (Not yet available)

The ESM system is part of the ECM/ESM system and detects, identifies and indicates the order of priority for countering threat emitters in the micro and millimeter wavebands. The ESM equipment is located in both wing tip pods and the avionics bay.

Missile Approach Warner (Not yet available)

The MAW sensor is a high performance radar system that detects high speed missiles, particularly short range passive missiles. The system detects incoming missiles from any angle of approach and is capable of tracking multiple threats to the aircraft.

DASS Sensors (Not yet available)

The system threat sensors are:

– The ESM
– The MAW
– The LW.

The MAW is an active system, the ESM and LW are both passive. These systems sensors are capable of identifying and tracking multiple threats and determining the mode of operation of weapons systems associated with the emitter. The systems also specify the order of threat importance to the DAC to enable efficient use of the available countermeasures.

Laser Warner (Not yet available)

The LW is a passive system, detecting and identifying laser emitters within two specific wavebands. The system is capable of tracking more than one laser emitter targeted on the aircraft using sensors positioned to ensure all round monitoring.

Countermaneuvers

The DASS may request one of the following maneuvers to best counter the threat to the aircraft:

– Required heading maneuver
– Support maneuvers
– Last ditch/escape maneuver.

Required Heading Maneuver

The system will indicate the aircraft heading that will be most effective for the automatic countermeasure being used against the threat.

Support Maneuvers

In some instances the DASS may request maneuvers in support of the countermeasure being used. These maneuvers may be multiple turns at a specific rate of g, or several legs to be flown in different directions.

Last Ditch/Escape Maneuver

In the event of no other countermeasures being available, the DASS will give the best direction to be flown in response to the threat.

Program Loading

The expendables release programs are predefined on the ground via Ground Support System (GSS). The program is loaded to the DASS either by the Ground Loader Unit (GLU) or PDS, which can also be used to modify GLU loaded chaff and flare release programs.

Up to thirteen expendables programs can be loaded to the subsystem, either via the MDEF or the HOTAS as follows:

MDEF selectable programs:

– Eight predefined
– Two manually defined
– Emergency to enable jettison of flares.

HOTAS programs:

– Two manually defined.

To provide a reversionary mode of operation, the default mixed load HOTAS program is loaded to both

the chaff and flare dispensers during the power on sequence.

MDEF Operation

When the DAS key, on the left glareshield, is initially selected, the moding keys will display the default configuration. None of the programs available are selected, consequently both the Data Entry Keyboard (DEK) and ROL are blank. If any of the eight programs, or the emergency program (EMER PROG), have not been loaded via the PDS, then the associated moding key will be occulted. If no mission expendables release programs have been loaded only MAN1 and MAN2 programs are available for selection. The release of expendables is achieved by use of the HOTAS chaff/flare switch.

To release flares the DASS requires:

1 Weight off wheels

2 The MASS set to LIVE

3 Expendables release manual control to be set to MAN or EXPD.

To release chaff the DASS requires:

1 Weight off wheels

2 Expendables release manual control to be set to MAN or EXPD.

Programs 1 to 8 and the EMER PROG cannot be modified by the DEK, however there initial contents can be viewed on the MDEF ROL.

The release of expendables will not be inhibited if there are insufficient expendables remaining for the whole of the program, ejection will continue until the dispensers are exhausted. The quantity of the available expendables are displayed on the MHDD stores format (MHDD/STOR) as well as on the DASS format. The quantity of chaff and flares remaining will be displayed on the MHDD/PA format for 5 seconds after expendables have been released. The voice warnings ‘flare empty’ and ‘chaff empty’ will be given when the expendables are exhausted.

The selected program is initiated by selecting the chaff/flare release switch to the forward position. If a program is deselected on the MDEF, part way through the dispense procedures, the release of expendables will continue to the end of the sequence specified by the program. The selected program will take precedence over the chaff only selection but the chaff only option will still be available if there are no programs selected. The release of expendables can only be terminated part way through a program by selecting the expendable release manual control to OFF.

The following abbreviations are used for flare and chaff ROL data:

– F - flare
– C - chaff
– SLV - number of salvos (maximum 15)
– SING - single dispenser operation
– DUAL - dual dispenser operation
– GAP - time between salvos (between 0.2 and 30.0 seconds with a time resolution of 0.1 second)
– EJECT - number of ejections per salvo (maximum 15)
– SP - time between ejections (between 00.1 and 30.0 seconds with a time resolution of 0.1 second)
– VAR - varying values during program execution
– TYPE - type of flare; one of five options available (1, 2, 3, 4 or MIXED) dependent of the type of flares loaded to the dispenser.

Where VAR follows the GAP, EJECT and SP data the time/number displayed is for the first salvo, subsequent timings/numbers cannot be displayed.

Predefined Program

Selection of any of the preloaded programs 1 to 8, by pressing the program key, displays the data for flare release, if applicable, on the ROL. Selection of the program is indicated by the boxing of the key legend. The only data entry key that can be selected is the second key on the top row, which has the legend C (chaff). Pressing this key displays the program chaff release data and the key legend changes to F (flare) to enable reselection of the program flare data.

Manually Defined Programs

Selection of either the MAN1 or MAN2 keys will display the flare dispense data for the HOTAS chaff and flare expendable release program and configure the DEK for data entry. If mission expendable data has not been loaded, via the GLU or PDS, the data entry fields on the ROL will be set to zero. Both the chaff and flare variables may be modified using the DEK. The VAR and MIXED options are not available for manually defined programs.

Flare Entries

Setting the SLV field to zero will occult all the other fields on the ROL. Setting a value will redisplay the fields, however, the fields displayed are dependent on the value set. Setting the value to 01 will default the dispenser field to SING and redisplay D on the DEK. Setting the SLV to any other value (02 to 15) will set the dispenser field to SING, GAP to 0.1S, TYPE to 1 and also redisplay D on the DEK. When the writer marker is on the TYPE field, only the numbers 1, 2, 3 and 4 are displayed on the DEK. Any fields set to dashes, by use of the CLR key, will be flagged as invalid after pressing the ENT key.

Chaff Entries

If the HOTAS default SLV entry is changed to 01, the GAP field will occult. Setting the SLV field to zero will occult all other fields. Resetting the SLV field to 01 from 00 will set the dispenser field to SING, the EJECT field to 01 and redisplay D on the DEK. Setting the SLV field to any other allowable value will set the dispenser to SING, GAP to 00.1S, EJECT to 01 and redisplay the D key on the DEK. Setting the EJECT field to 01 will occult the SP field. When EJECT is then set to a higher value, 00.1S will be displayed in the SP field. Any field set to dashes by use of the CLR key will be flagged as invalid after ENT is selected.

HOTAS Default Programs

Two HOTAS default programs are loaded into the DAC, one for chaff release and the other for chaff and flare release. The chaff program is initiated by selecting the throttle tops chaff/flare release switch to the forward position; provided another MDEF program option has not been selected. The chaff and flare HOTAS default program is initiated by selecting the throttle tops switch to the aft position.

To ensure an immediate release of both chaff and flare, initiation of the HOTAS chaff and flare default program has priority, and if necessary interrupts and terminates the current release selected by forward switch selection. Reselection of the forward switch position will initiate the complete release sequence of the terminated program.

Jettison of Flares

NOTE

The jettison of flares is not initiated by the emergency stores jettison push button (EMER JETT) on the left quarter panel.

The EMER PROG will enable the jettison of the remaining flares to reduce the fire hazard prior to an emergency landing. This is achieved by selecting the EMER PROG on the MDEF followed by a momentary selection of the HOTAS expendables switch to the forward position.

Program Data Erasure

The following data will be automatically erased when power is removed after engine shutdown:

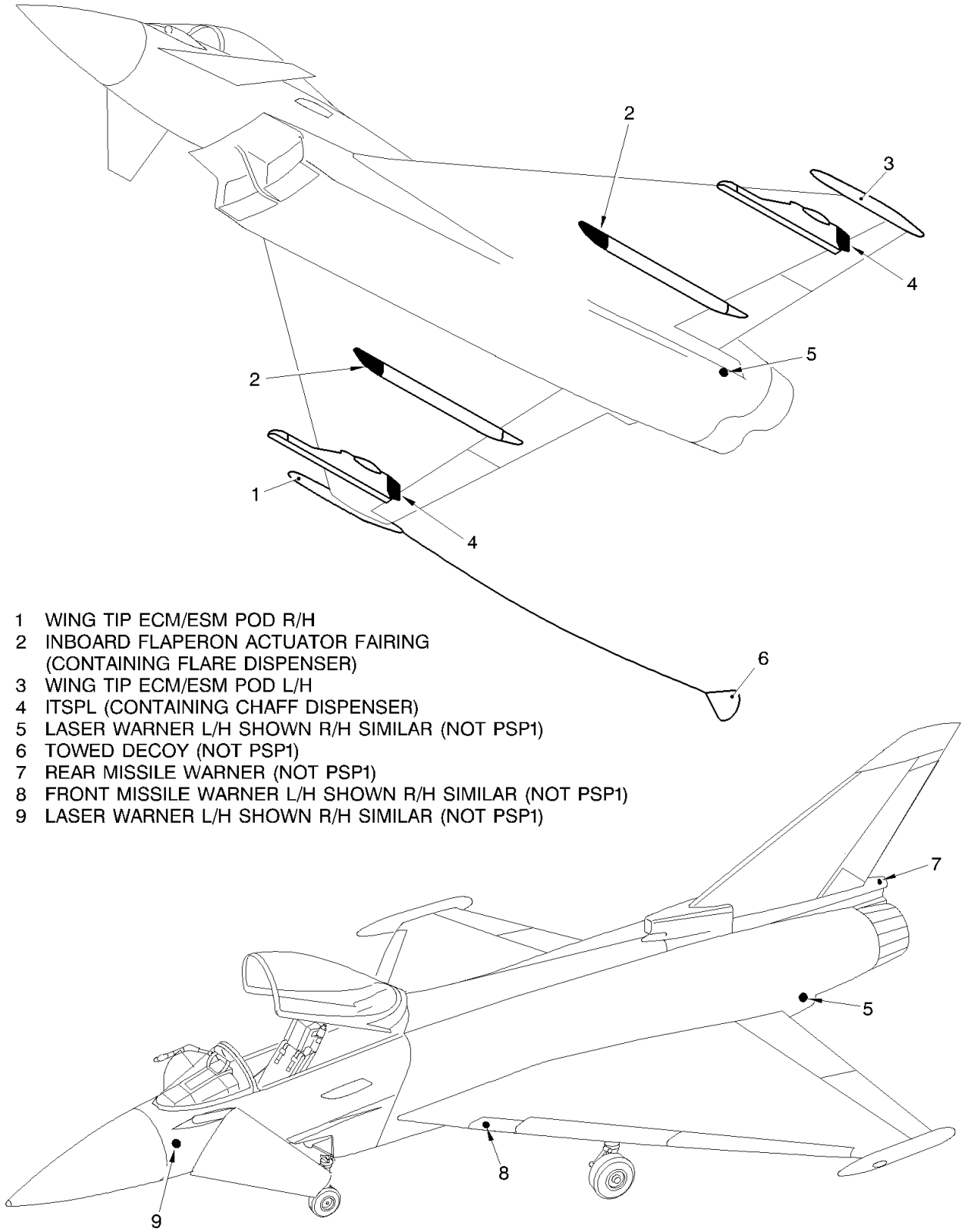
– The PDS updates to the GLU loaded mission data
– The two manually defined programs
– The back up programs loaded to the chaff and flare dispensers.

The GLU loaded mission data is retained for future missions, however, it is erased when:

– The SECURE DATA ERASE push button on the left rear console is pressed.
– The pilot ejection signal is received by the DAC.

Reversionary Mode of Operation

In the event of a DAC failure the subsystem will adopt the reversionary mode. Expendables release programs stored within the dispensers during subsystem initialization are initiated using the HOTAS chaff and flare release switch. Selection of the switch to the forward position will release chaff and selection to the aft position will release chaff and flare.



1 WING TIP ECM/ESM POD R/H
2 INBOARD FLAPERON ACTUATOR FAIRING (CONTAINING FLARE DISPENSER)
3 WING TIP ECM/ESM POD L/H
4 ITSPL (CONTAINING CHAFF DISPENSER)
5 LASER WARNER L/H SHOWN R/H SIMILAR (NOT PSP1)
6 TOWED DECOY (NOT PSP1)
7 REAR MISSILE WARNER (NOT PSP1)
8 FRONT MISSILE WARNER L/H SHOWN R/H SIMILAR (NOT PSP1)
9 LASER WARNER L/H SHOWN R/H SIMILAR (NOT PSP1)

Figure 1.307 - Defensive Aids Subsystem Equipment

Defensive Aids Computer

(1B-B-99-01-00-00A-043A-A Issue 006)

General

The Defensive Aids Computer (DAC) provides:

– control of manual initiated dispensing of Chaff and/or Infra-Red (IR) decoys, in accordance with pre-programmed sequences
– manages RF interoperability of all on-board emitters and receivers by means of a programmable blanking and suppression matrix
– provides a “stealth management” function for the on-board emitters
– controls Radar channel allocation
– limited support for the ESM/ECM and Missile Warner (MW) equipment. Note: Automatic dispensing of expendables in response to ESM/ ECM or Missile Warner outputs is not supported at PSP1.

The DAC interfaces with other LRIs via the Attack Bus and the DASS Bus and provides the following functions:

DASS Counteractions

At IOC the available DASS counteractions are limited to the manually commanded dispensing of chaff and/or IR decoys from two chaff dispensers and two flare dispensers.

RF Interoperability

The aim of RF Interoperability is to maximize weapon system performance by utilizing suppression and blanking techniques on a priority dependent on the current scenario, while minimizing the loss of performance caused by mutual interference. This is achieved by careful selection of operating frequencies, antenna locations, management of emissions in the time and frequency domains and, as a last resort, suppression and blanking. Management of emissions and suppression / blanking is shared between the DAC and the ESM/ECM equipment.

Stealth Management

The DAC also contributes to overall stealth moding by intelligently managing ECM transmissions in accordance with PDS-loaded criteria.

This means, for example, that transmissions will be inhibited throughout a specific sortie unless the DASS decides to respond with all necessary countermeasures when it detects threats beyond pre-defined thresholds.

The Stealth Management function enables the pilot to inhibit transmissions from the following groups of RF emitters:

– Radar
– IFF Interrogator
– IFF Transponder
– RadAlt
– Tacan

Radar Channel Control

A default channel pair allocation, contained in mission data, will be employed unless the pilot inputs a modified channel allocation. When the channel allocation is modified, the DAC will check that the new allocation is valid. If valid, the selected channel allocation is passed to the Radar for application.

Mission Data Loading

An area of non-volatile "sensitive memory" (NVM) is provided within the DAC for storage of classified mission data. The contents of this memory will automatically be erased in the event of pilot ejection, physical removal of the DAC from the aircraft or pilot operation of the crypto erase switch in the cockpit.

The DAC may be loaded with two types of mission data:

– Multi Mission Data (MMD) and
– Single Mission Data (SMD).

Multi-mission data are loaded from the Ground Loader Unit (GLU) into the DAC's NVM to avoid loss of such data in the case of a power interruption. Once the multi-mission data has been loaded into NVM and on each subsequent power-up, the DAC will copy the multi-mission data into a "working copy" in RAM, which may be modified by single-mission data.

Multi-mission data for ESM / ECM, MW, LW are also stored in the NVM and sent to the equipments following power-up or following the arrival of new multi-mission data for these units or following a request by these units.

Single-mission data is also loaded into the DAC's non-volatile memory, received from the Portable Data Store (PDS), via the Mission Data Loader Recorder (MDLR) and the Attack bus.

This single-mission data may modify all or part of the "working copy" of the multi-mission data. Single-mission data for ESM/ECM, MW, LW is also stored in the DAC's sensitive memory and is downloaded to these equipments.

Built In Test

A BIT function runs continuously (CBIT) and an interruptive BIT function (IBIT) will be performed if requested.

Health monitoring

The DAC will monitor the status bits of all Remote Terminals (RT) on the DASS bus. Confirmation of RT failures will result in transactions being disabled, maintenance data being generated and warnings being set. When the ESM/ECM Remote Terminals fails on the DASS bus, the concerned transactions can be switched to the Attack bus.

The DAC will monitor IBIT requests and will check that LRIs on the DASS bus have started and have finished IBIT.

DWP Warnings

The following warning is available for the DAC:

DAC Failure Warning

WARNING	CATEGORY	VOICE MESSAGE	DWP CAPTION	SYSTEM ACTIONS	MISSION CONSEQUENCES	SYSTEM CONSEQUENCES
DAC Failure	3	DASS Computer	**DAS CPTR**	Expendables release relies on back-up program loaded in dispensers. RF interoperability relies on loaded default data	Radar performance in GUN and VISident mode may be degraded	MDE Radar channel input lost. MDE CHAFF/ FLARE modes lost. CHAFF / FLARE switch, forward function lost (default chaff only or expendables program).

Defensive Aids Subsystem

(1B-B-99-00-00-00A-111B-A Issue 003)

MHDD Formats

The quantity of available expendables is displayed on the Multi-Function Head Down Display Stores format (MHDD/STOR), refer to Figure 1.308 and on the MHDD/DASS format, refer to Figure 1.309 . The quantity of chaff and flares remaining will also be displayed on the MHDD/PA format for 5 seconds after expendables have been released.
For additional information, refer to:

– Defensive Aids Subsystem pag. 1-579
– Defensive Aids Subsystem pag. 1-588.

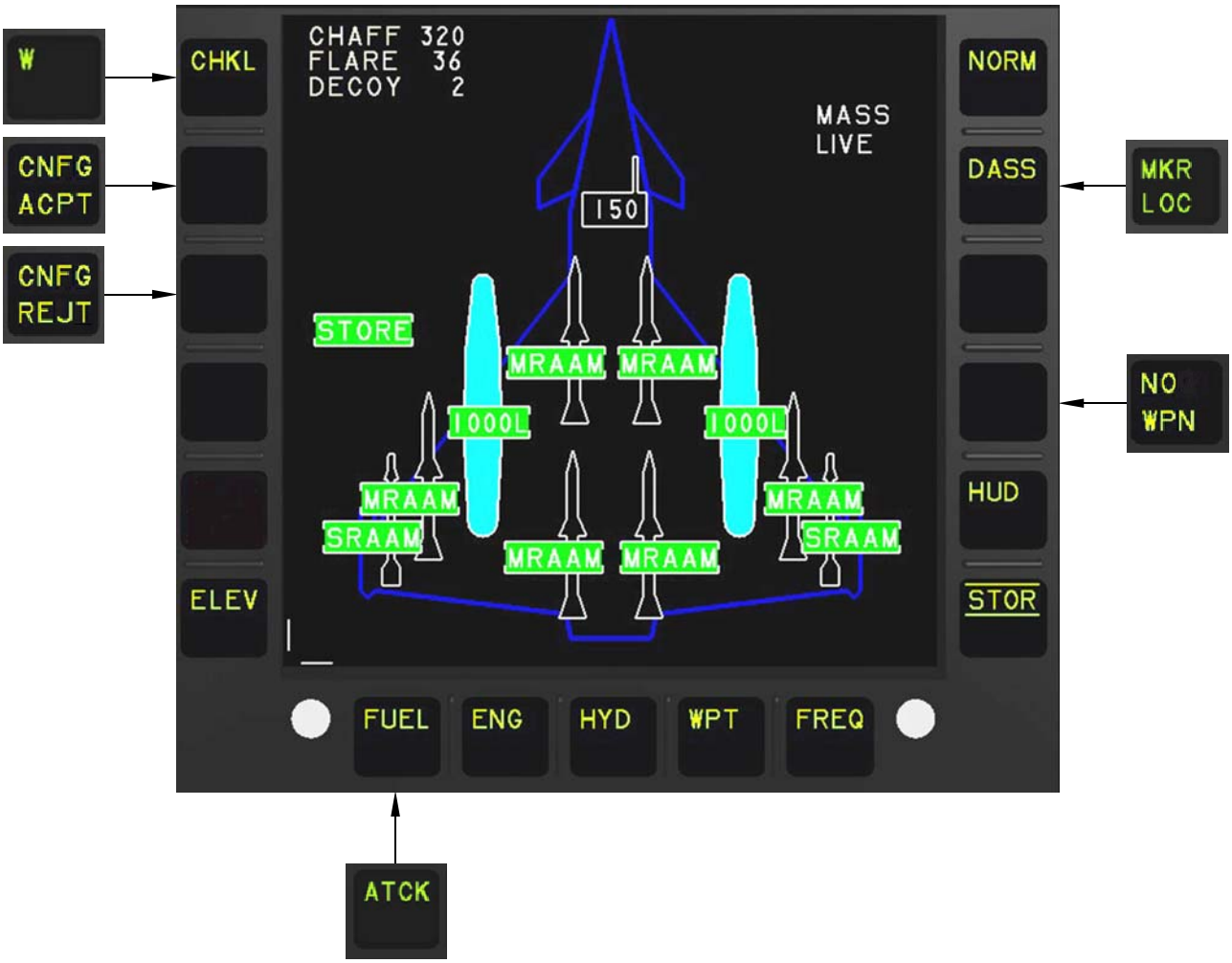


Figure 1.308 - MHDD - Stores Format

Figure 1.309 - MHDD - DASS Format

Defensive Aids Subsystem

(1B-B-99-00-00-00A-111A-A Issue 003)

Introduction

The release of expendables is programmed either through the Portable Data Store (PDS) or via the moding keys and Manual Data Entry Facility (MDEF) located on the left glareshield, refer to Figure 1.310 . The DASS functions are accessed via the DAS subsystem key.

Up to ten chaff and/or flare programs can be loaded through the PDS in mission data. Of these, two (the MAN programs) can be amended or created in flight using the MDEF. To release a program, the aircrew first select the required program on the MDEF moding key (the program details will be displayed in the ROL and then selects the Expendables Release Manual Control (Figure 1.311) to EXPD.

If the Expendables Release Manual Control is set to MAN, the aircrew can release one of two PDS loaded emergency countermeasure programs, using the HOTAS chaff/flare release switch (Figure 1.312). Pressing this switch forward results in the release of the emergency chaff program or, if a program is currently selected on the MDEF, the release of that selected program. If the switch is pulled back, the emergency chaff and flare program is released.

NOTE

The emergency programs are additional to the ten predefined, shown on the MDEF, and cannot be modified from within the cockpit.

For detailed information of Defensive Aids Subsystem (DASS) operation and its related displays, refer to:

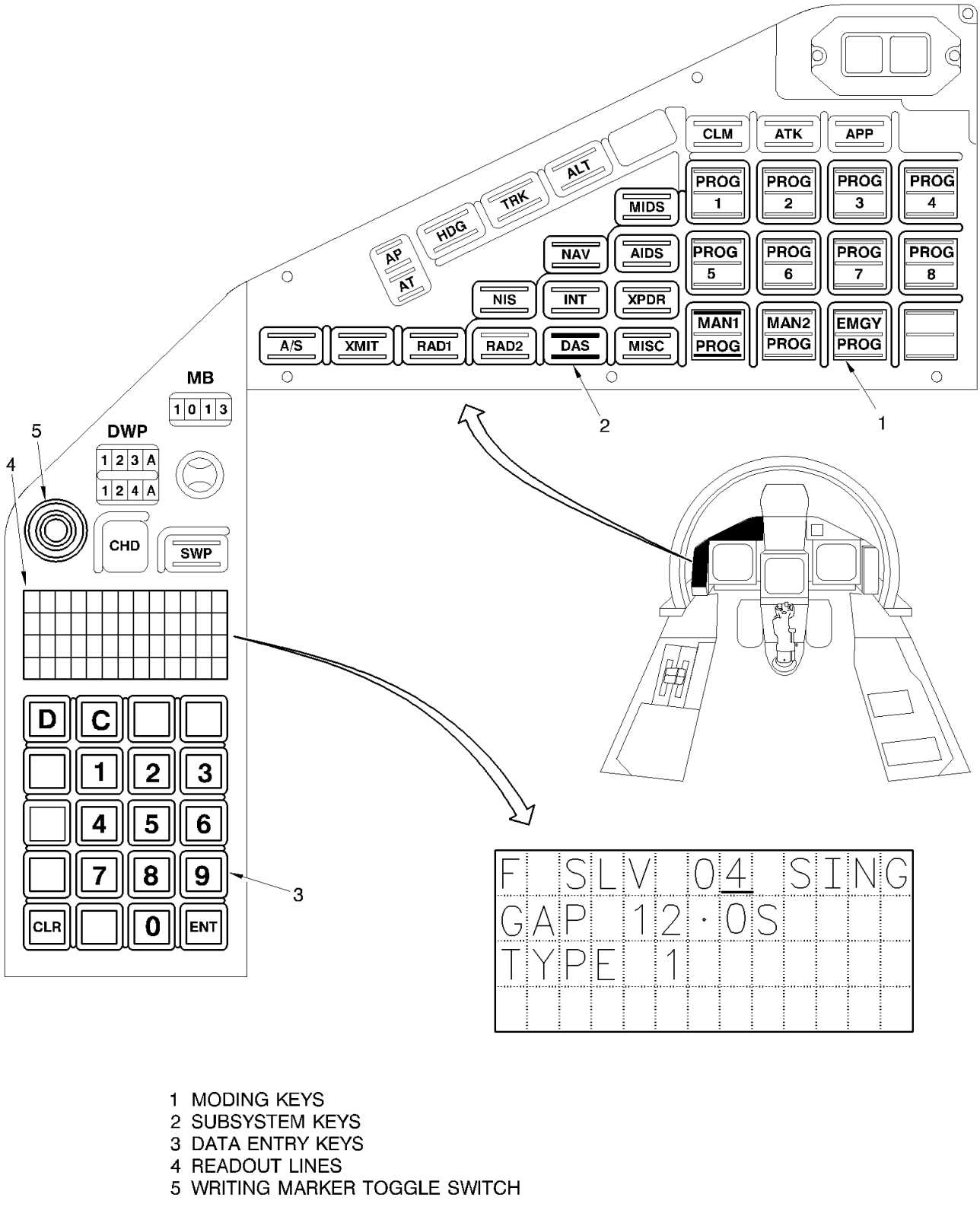
- Defensive Aids Subsystem pag. 1-579
- Defensive Aids Subsystem pag. 1-585.

Expendable Release Manual Control

The expendables release manual control is a three position toggle switch. The switch positions are annotated EXPD (expendables), MAN (manual) and OFF, refer to Figure 1.311 .

HOTAS - Chaff and Flare Release Switch

The HOTAS chaff and flare release switch is a spring loaded toggle switch installed on the left throttle top, refer to Figure 1.312 .



1 MODING KEYS
2 SUBSYSTEM KEYS
3 DATA ENTRY KEYS
4 READOUT LINES
5 WRITING MARKER TOGGLE SWITCH

Figure 1.310 - Moding Keys and Manual Data Entry Facility (MDEF) - Left Glareshield

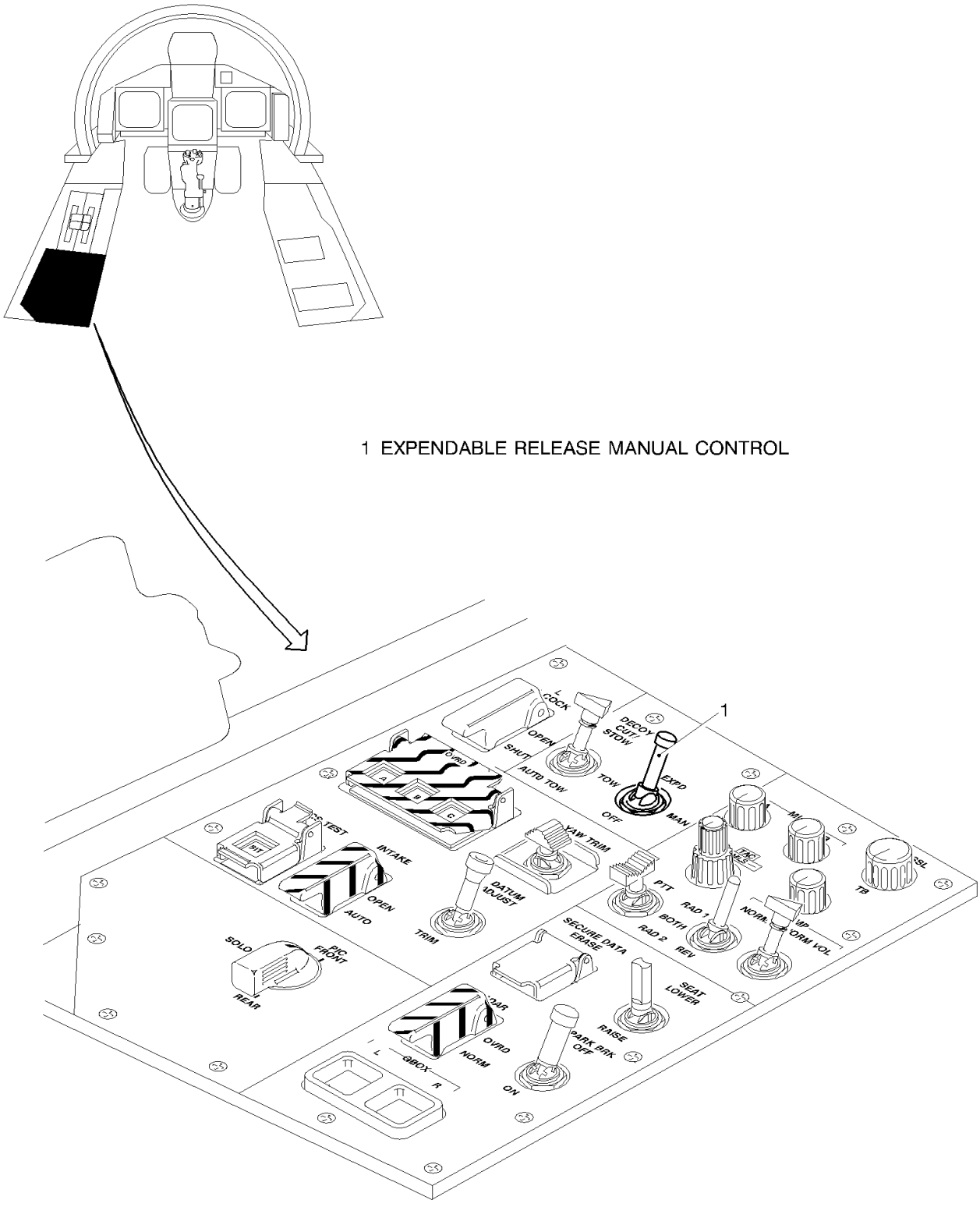


Figure 1.311 - Expendable Release Manual Control - Left Rear Console

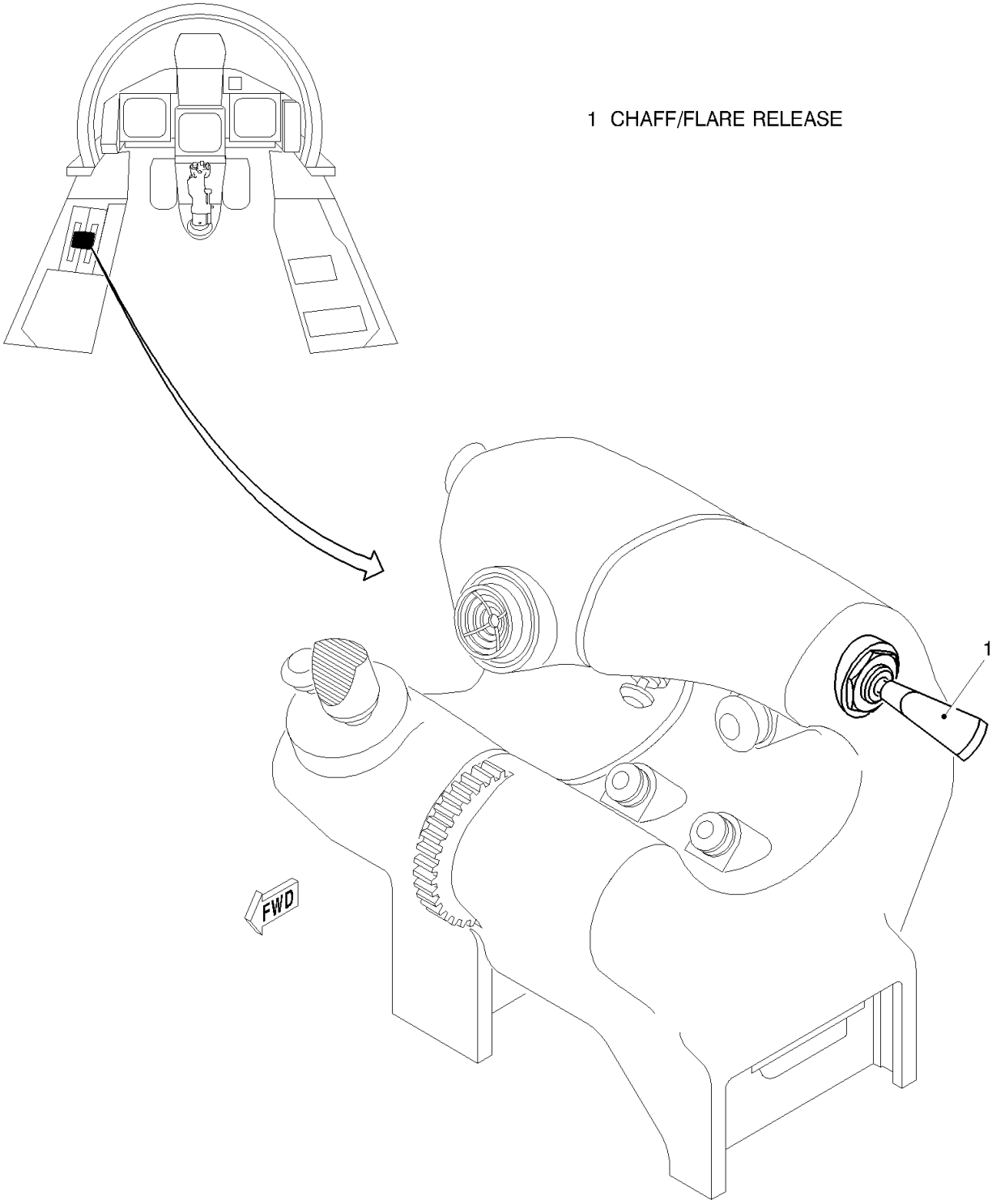


Figure 1.312 - Chaff and Flare Release - Left Throttle Top

Data Loading/Erasing

(1B-B-99-11-03-00A-043A-A Issue 005)

Introduction

Aircrew can load specific mission data to the aircraft avionic systems using the Portable Data Store (PDS) and Mission Data Loader Recorder (MDLR). The PDS is a solid state memory device used to store specific mission data so that it can be quickly transferred to the aircraft avionic systems using the MDLR as an interface. The pilot inserts the PDS into the MDLR when he enters the cockpit and the stored mission data is automatically downloaded to the avionics systems when power is applied to the cockpit bus upon aircraft power-up. Aircraft mission data from the avionic systems can also be recorded back onto the PDS.

Data Loading/Recording

On aircraft power-up, after successful completion of the Power-up Built-in Test (PBIT), the MDLR is ready for data loading and recording, once the PDS is inserted.

Mission Data Load

Before mission data can be downloaded to the aircraft avionics systems, the PDS must be installed in the MDLR and its cover closed. On aircraft power-up, the MDLR performs a PBIT and after successful completion, the first block of mission data is sent from the MDLR/PDS to the attack computer. The attack computer analyzes this data and establishes a transaction table to pass the remaining mission data to the different avionics subsystems from the MDLR. The mission data is sent to the following subsystems:

– Armament Control System (ACS)
– Attack and Identification System (A&I)
– Communication System (COMM)
– Defensive Aids SubSystem (DASS)
– Displays and Controls (D&C)
– Navigation System (NAV).

When the mission data download is completed, the attack computer sets the MDLR to the mission data record mode. If it is necessary to repeat the PDS download, it can be initiated by opening and reclosing the MDLR door.

Mission Data Record

The MDLR receives mission data from the DASS, A&I, NAV and IMRS subsystems. This mission data is then recorded to a specific area on the PDS non-volatile memory so as not to overwrite the existing mission data.

Data Erasing

The mission data contained in the PDS will automatically be erased if the aircrew eject from the aircraft or the ‘guarded’ SECURE DATA ERASE push switch is operated. The time taken to erase the mission data, during aircrew ejection, is less than 0.4 seconds for an 8 MByte PDS. Erasure of mission data by operation of the ‘guarded’ SECURE DATA ERASE push switch can take up to 10 seconds.

Transmitter Management

(1B-B-99-30-00-00A-043A-A Issue 006)

Introduction

Transmissions from the on-board RF transmitters can be inhibited to aid aircraft stealth. This sub-system is used to inhibit emissions from the following transmitters:

– Search radar (ECR 90)
– IFF interrogator
– IFF transponder
– Radar altimeter
– TACAN.

There are three transmitter management modes, all normal (Para), all silent (Para) and program (Para), that can be selected via the transmitter subsystem (XMIT) moding key on the Manual Data Entry Facility (MDEF). In addition, a ‘null’ state (Para), in which the search radar and interrogator are enabled, can be entered from the all silent mode.

Operation

The default setting for XMIT is normal operation (ALL NORM) for all transmitters. The default MDEF display on XMIT selection is shown in Figure 1.313. The MDEF moding keys in this example show ALL NORM and the RDR CHAN selected (boxed). The individual transmitter moding keys indicate the state that will be selected when the PROG key is selected. In this example they are all set to NORM, however these preselections can be loaded in mission data via the Portable Data Store (PDS), and can be ammended at any time during flight. The MDEF ROL and Data Entry Keyboard (DEK) are configured for radar channel display/entry; the default moding key selection when XMIT is selected. Radar operation is described in Radar pag. 1-482.

All Normal Mode

‘All Normal’ is the default mode of operation and is indicated by the ‘boxing’ of the ALL NORM moding key. Selection of this moding key from another mode

removes any suppression currently being applied on grounds of stealth.

All Silent Mode

Selection of this mode inhibits transmission from all of the transmitters: selection of the all silent mode is indicated by the 'boxing' of the ALL SLNT moding key. An indication of radar inhibit is also presented on the Multifunction Head Down Display (MHDD)/ Attack (ATCK) and Pilot Awareness (PA) formats, by the dashing of the radar scan lines and, the PA format, by a cross through the transmit icon.

On the Attack format, Figure 1.314, the radar silent mode is indicated by the radar scan center and width lines being dashed, and by the display of the active scan icon (Para). The all silent mode is indicated on the PA format by the radar scan coverage and maximum range arc being dashed, and by the display of five small arcs overlaid by a cross immediately above the present position symbol, Figure 1.315 .

Program Mode

Selection of the program moding key (PROG) inhibits transmission from the avionics subsystems that have been preselected for silent operation. With XMIT selected the program mode of operation is indicated on the radar transmitter moding keys, Figure 1.316 . There are two selectable states for each transmitter, inhibited (SLNT) or normal operation (NORM).

The default selection, unless modified via the PDS load, is normal operation for all transmitters. Transmitters are preselected for silent operation by pressing their moding key, SLNT is displayed as the lower key legend. Those selected for silent operation will have their moding key legends 'boxed' when the program mode is initiated.

Radar Moding in ALL SLNT and PROG

To allow immediate availability of the radar and IFF interrogator when they are inhibited in ALL SLNT or PROG modes, the following automation is provided.

Radar Active Scan

The active scan icon (Figure 1.314) is automatically displayed on the Attack format when the search radar is selected to silent mode, either through ALL SLNT or PROG. An X-Y insert over the icon will initiate two full scans in whatever mode the radar was in when ALL SLNT was selected. The active scan icon is then no longer displayed, and the radar scan center and width lines become solid for the duration of the scan. The radar will then return to silent mode with the scanner parked in a position that offers the least head-on radar cross sectional area.

Air Combat Moding

If a radar Air Combat Mode (ACM) is selected, stealth suppression of the radar and IFF interrogator is automatically removed; the MDEF XMIT key is automatically selected and the RDR and INT moding keys will show NORM (boxed). The ALL SLNT or PROG key, whichever was selected, becomes unboxed but all the other individual transmitter settings continue to be applied. If another radar mode is then selected the radar and IFF interrogator will show NORM. However, if the radar break lock is selected from the ACM then the program interrogator and radar preselections will be retained.

XMIT Null State

The null state is entered when an ACM is selected during all silent moding. In the null state the search radar and IFF interrogator are triggered into normal operation. All other radar transmitters modes are unaffected during this state. XMIT is automatically selected on the MDEF when this state is entered. Deselection of the ACM via the HOTAS break-lock switch, will return the search radar and IFF interrogator to the all silent state. However, the LHGS would remain in the null state until the pilot makes a selection of either Program, Silent or Normal. If any other radar mode is selected, e.g. Track While Scan (TWS), during the null state, then both the search radar and interrogator will remain active until either PROG or ALL SLNT is reselected.

IFF Transponder

Ejection or selection of IFF EMGY will activate the transponder in emergency mode. Deselection will return the transponder to silent mode. Similarly, selection of ID on the RHGS will activate the transponder in ident mode and will return to silent mode when complete.

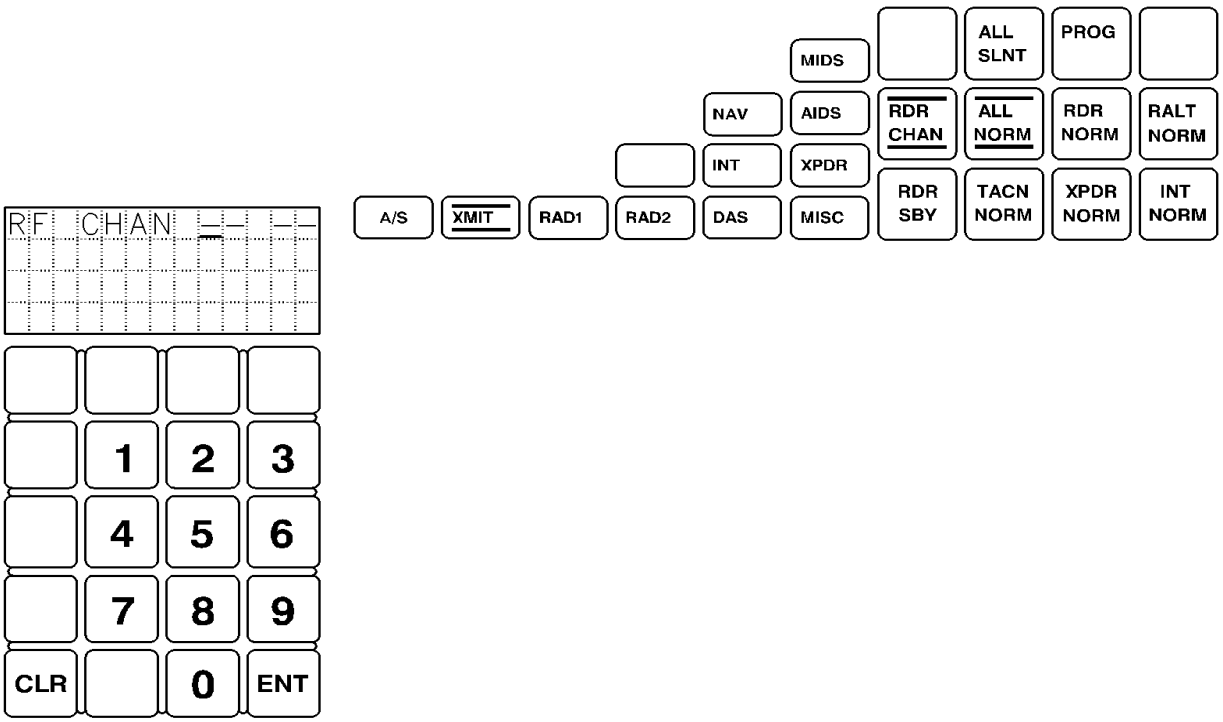
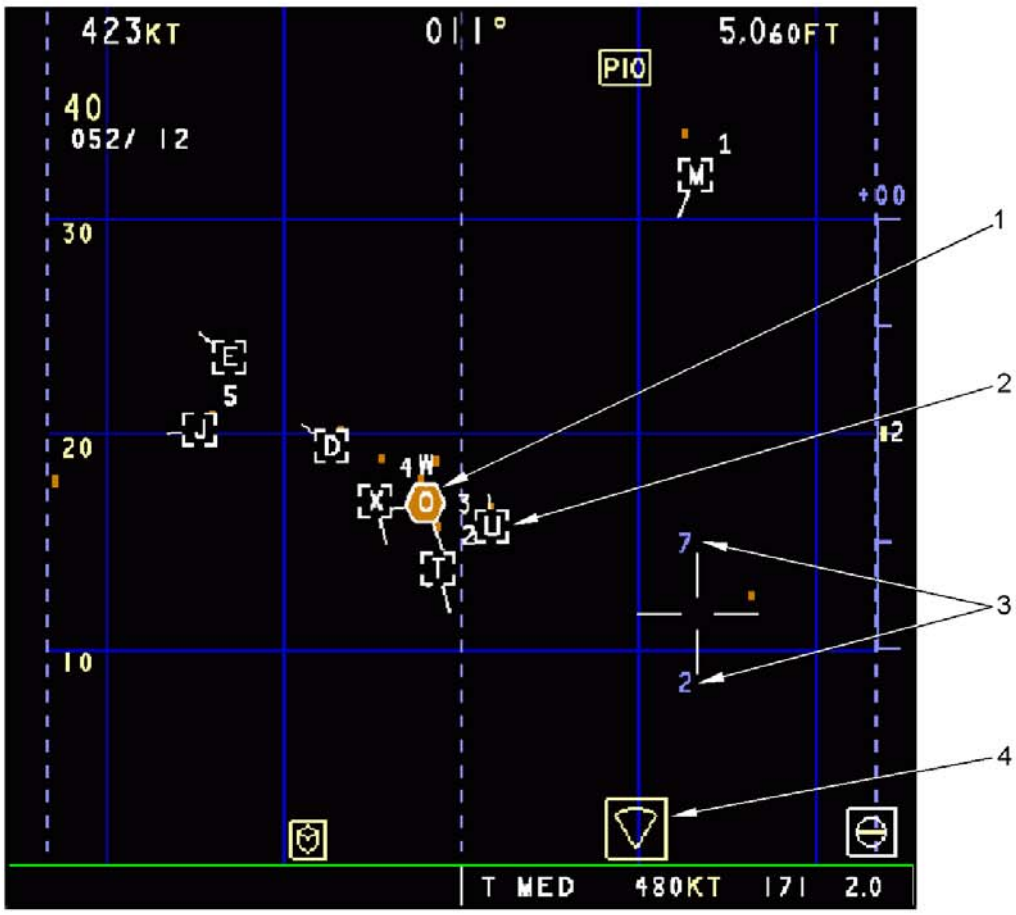


Figure 1.313 - MDEF XMIT SS Default Configuration



1 TGS
2 TRACK
3 RADAR ALTITUDE COVERAGE
4 ACTIVE SCAN ICON

Figure 1.314 - Attack Format - Radar Silent Mode

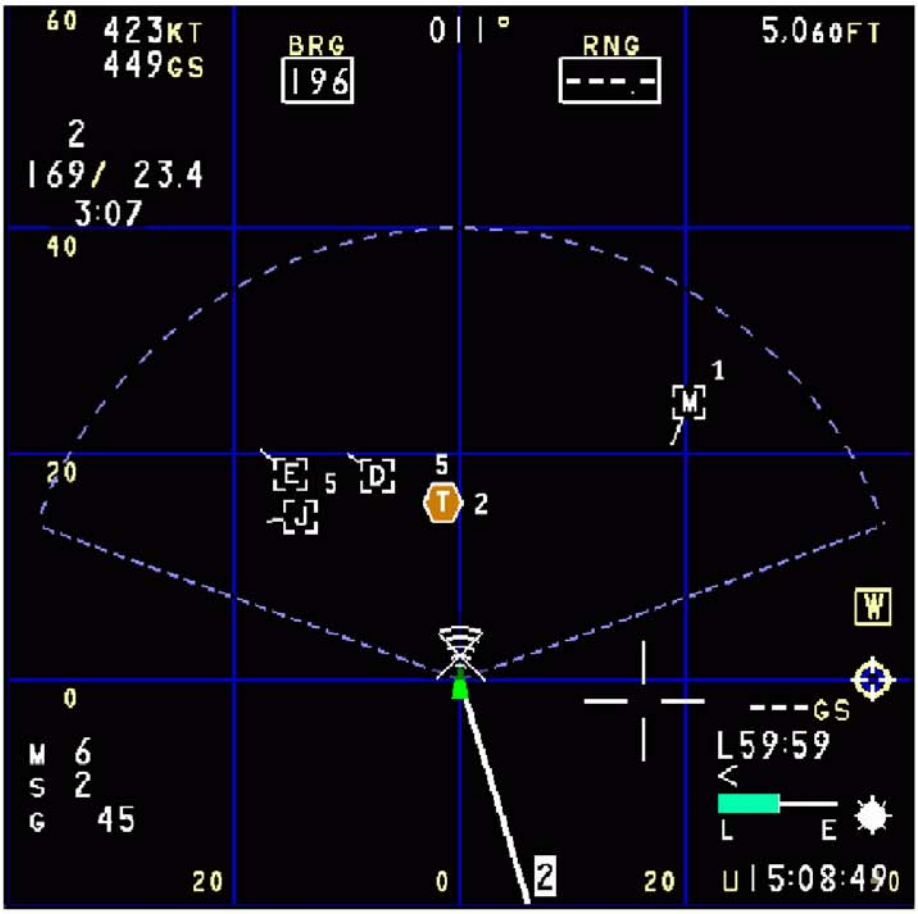
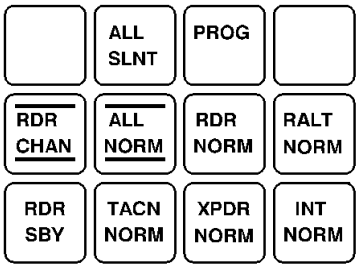
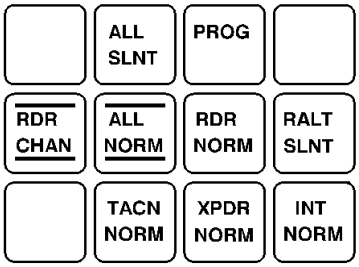


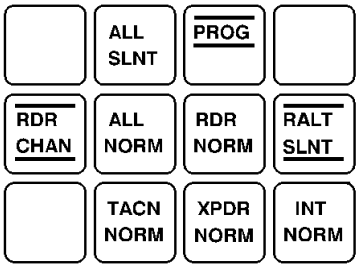
Figure 1.315 - PA Format - All Silent Mode



DEFAULT CONFIGURATION



RADAR ALTIMETER SELECTED TO SILENT FOR PROGRAM MODE



PROGRAM MODE SELECTED INDICATIONS

Figure 1.316 - MDEF Transmitter Moding Keys

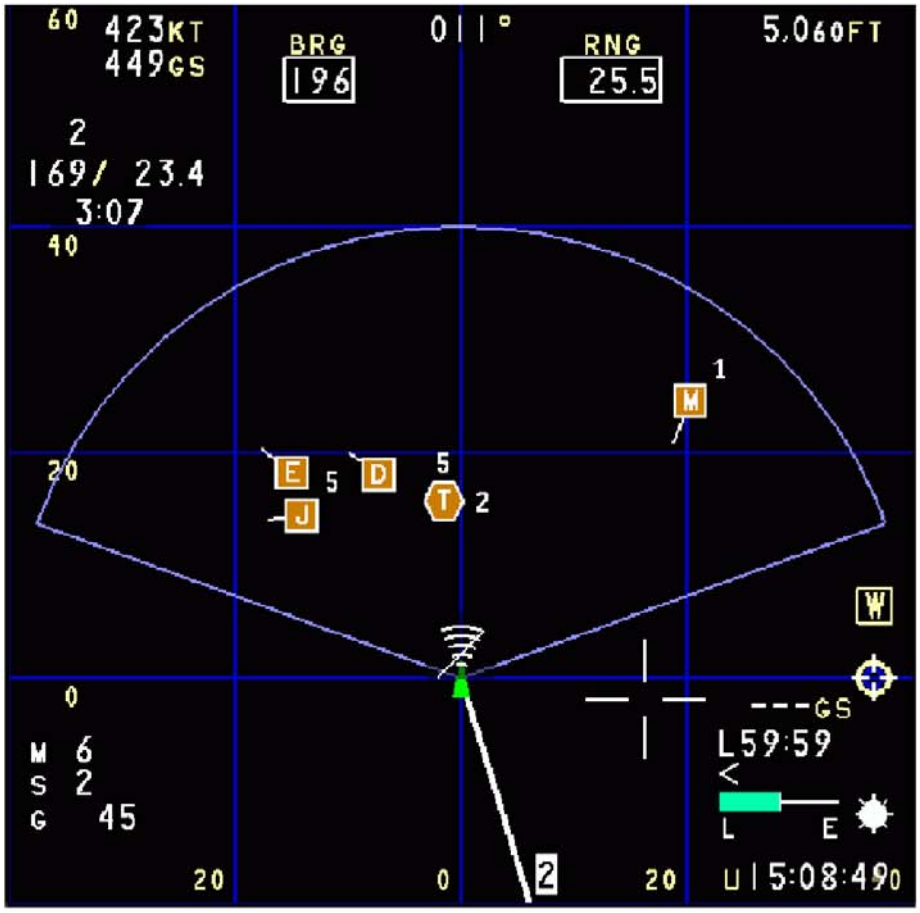


Figure 1.317 - PA Format - Transmitter Inhibit Program Indication

WEAPON SYSTEM

Weapon Aiming/Release System

(1B-B-94-10-00-00A-043A-A Issue 005)

Introduction

With the present version of software the following weapons can be made available:

– Gun
– AMRAAM
– AIM 9L

For additional information of stores management, weapon select/reject and displays/controls, refer to Stores pag. 1-615.

Gun

The gun is enabled when the MASS is set to LIVE and the gun is selected on the HOTAS weapon selector switch. For additional information, refer to Hands on Throttle and Stick pag. 1-107.
There are three gun aiming modes:

– Mixed; a combination of primary and secondary
– Primary
– Secondary.

Mixed Mode

The mixed mode is entered by default on selecting gun on the stick top when in radar Lock Follow (LF) mode. This mode is a combination of the both primary and secondary modes, displaying the director gunsight and the historic bullet trace. Also displayed are:

– the Target Designator (TD) box
– the gun launch success zone, which includes a maximum advised fire range
– the gun range circle, which includes a minimum range marker
– a digital range rate cue tied to the range circle in addition to the normal range rate cue below the launch success zone.

The aiming pipper is placed at the centre of the gun range circle, and is positioned by the weapon aiming calculations on the optimum firing point. It is not necessary to achieve stabilized tracking on the target to achieve a firing solution, if the pipper is on the target, fire.
The wingspan markers are not displayed in this mode of operation.

Primary Mode

The primary mode is entered by reselection of the gun on the sticktop when in the radar LF mode. The director gunsight, which predicts the future target position from radar data, is displayed on the HUD. Also displayed are:

– the TD box
– the gun launch success zone, which includes a maximum advised fire range
– the gun range circle, which includes a minimum range marker
– a digital range rate cue tied to the range circle in addition to the normal range rate cue below the launch success zone.

The aiming pipper is placed at the centre of the gun range circle, and is positioned by the weapon aiming calculations on the optimum firing point. It is not necessary to achieve stabilized tracking on the target to achieve a firing solution, if the pipper is on the target, fire.

Secondary Mode

The secondary mode is automatically displayed on selection of gun, when the radar is not locked. The weapon system calculates the instantaneous trajectory of a stream of bullets and displays them as a historic tracer line. A "dark bullet" (small gap that moves down the tracer line every two seconds) is displayed to aid the pilot assessment of the firing point. Target wingspan markers, calibrated and graduated, for 30 ft, 40 ft and 50 ft wingspans, are displayed at the 1000 ft, 2000 ft and 3000 ft positions.
The pilot aims the sight by maneuvering the aircraft so the tracer lies along the anticipated target flight path, and fires when the estimated time of flight of the bullet equals the estimated time of flight for the target to reach that point. This estimation is aided by the "dark bullet" and the range bars.
There are no accurate launch success zone or range rate displays. If the target being shot at is also the number one Designated Target List (DTL) target, a TD box will be displayed, but without the radar being locked the system latency means that the positional data is not accurate enough for precise A-A gunnery.

AMRAAM

There are two modes of AMRAAM operation; normal and visual. In normal mode, an AMRAAM is automatically allocated to the number one target in the DTL when the weapon is selected via the stick top. Multiple AMRAAM can also be allocated for release against a target. If this option is selected, the trigger must be pressed to launch each allocated missile as ASRAAM will not launch in salvo. The following information is displayed on the Attack format when the missile is selected and at least one target nominated:

– AMRAAM range scale

– Time for the target to enter the missile envelope/ flight time to go autonomous if launched now.

The following information is displayed on the HUD when the missile is selected and at least one target nominated:

– Digital range to target readout
– Target aspect angle
– Closing speed
– POI (Probability of Intercept)
– Allowable Steering Error (ASE) circle and associated steering cross.

A target range circle provides an indication of distance to target between 0ft and 12 000 ft. The range is shown as a circle centred on the aircraft symbol which unwinds in an anti-clockwise direction as the range to target decreases. A minimum range marker is displayed at the 12 o'clock position when the range to target is >12 000 ft.
Optimum missile approach steering is achieved by maneuvering to keep the steering cross within the ASE circle. The launch success zone calculations show maximum, no escape and minimum ranges, calculated assuming that the steering cross is within ASE circle at launch, i.e. the launch success zone shows optimum performance, not instantaneous performance.

Normal Mode

In normal mode, outside 1.3 Rmax, the steer cross gives fighter-target collision steering in azimuth and optimum AMRAAM pre-launch steering in elevation. At 1.3 Rmax, steering ramps down to ensure that by Rmax the cross gives missile-target collision steering in both azimuth and elevation.
After missile release, radar updates on the target position are transmitted to the AMRAAM via the radar sidelobes. Turnaway limits, to help the pilot retain the target within the radar scan coverage, are displayed on the HUD until the missile goes autonomous. The ASE circle, steer cross and turnaway limits are also displayed on the CD ball, displayed on the Attack and Elevation formats when the PA format CD ball soft-key is selected.

Visual Mode

Visual mode is selected automatically when no targets have been nominated or when target data quality is insufficient for adequate missile priming. The only indication of automatic selection of visual mode is a "V" in the HUD weapons status block. The pilot can also select visual mode at any time by a second successive selection of AMRAAM on the weapons selector switch. Selection of visual mode is indicated by a "V" in the HUD weapons status block and the display of the AMRAAM target acquisition circle on the HUD. The acquisition circle approximates to the field of view of the missile seeker on launch. When the missile is fired in visual mode, the seeker head is active immediately on launch and the missile will home on the first target detected.

SRAAM

SRAAM is selected via the stick top air to air weapon selector. The missile has three modes of operation:

– Slaved to the number one target in the DTL
– Slaved to the weapon system boresight, when no targets nominated
– Slaved to the X-Y marker, when in manual target designation mode.

The manual mode of operation is entered by a second press of the stick top air to air weapon selector. In this mode of operation the X-Y marker is used to slew the missile seeker head over the desired target position on the HUD.

A target range circle provides an indication of distance to target between 0 ft and 12 000 ft. The range is shown as a circle centred on the aircraft symbol which unwinds in an anti-clockwise direction as the range to target decreases. A minimum range marker is displayed at the 12 o'clock position when the range to target is >12 000 ft.

The weapons system takes into account obscuration and aircraft CG when allocating a missile for the target. An SRAAM range scale showing maximum and minimum range, current target range, no-escape range, shoot cue and breakaway indications are displayed on the HUD when appropriate.

Armament Control Subsystem

(1B-B-94-70-00-00A-043A-A Issue 003)

The Armament Control Subsystem (ACS) is part of the Armament System.

The ACS performs the following main functions:

– Weapons and stores configuration monitoring and management
– Weapons selection, arming, harmonization, priming and release control
– Gun selection and firing control
– Stores jettison (EJ/SJ) control
– Weapons and stores servicing data management
– Armament system monitoring and maintenance data management
– Weapon training facilities
– FCS, PRP, and DASS operation support.

NOTE

The ACS supports the following weapons management:

- AIM-9L: FROM WING TIP AND OUTBOARD STATIONS
- AMRAAM: FROM FUSELAGE AND OUTBOARD STATIONS
- GUN: FIRING CONTROL

The ACS performs safety critical and non safety critical functions which are separated and isolated, physically and electrically. The Armament Control Subsystem includes the following LRI:

- Safety Critical Armament Controller (SCAC)
- Non Safety Critical Armament Controller (NSCAC)
- Master Armament Safety Switch (MASS)
- Armament Safety Break Contactors (ASBC)
- Distribution Unit (DU)
- Fuselage Station Unit (FSU)
- Wing Station Units (WPSU)
- Integrated Tip Station Units (ITSU).

The LRI of the ACS are interconnected by the Weapons databus and/or dedicated links. The system communicates with the rest of the Avionic Systems via the Attack databus. The Armament sub-system is connected by dedicated links to the Trigger, Weapon Commit/Release Control, Late Arm, Selective Jettison (SJ) and Emergency Jettison (EJ) controls.
The ACS has duplicated channels (Ch. A and Ch. B) to ensure that no single defect within the sub-system can cause:

- the loss of the EJ or SJ function when requested.

In order to operate, the ACS needs both 28V DC and 115V AC electric power supplies:

- 28V DC power is provided via the two independent aircraft bus bars PP2 and PP3
- 115V AC power is provided via the two independent aircraft bus bars XP1 and XP2.

Safety Critical Armament Controller (SCAC)

The SCAC controls all ACS safety critical functions.
The SCAC has a two channel architecture and its two channels are functionally synchronous.
The SCAC can operate in two modes: Normal or Reversionary. The operational mode is controlled by the SCAC NORM/REV switch, where respectively NORM means the SCAC operates in dual channel and REV means that single channel operation of the SCAC is authorized.
The SCAC interfaces with the Weapon bus and the Attack bus as double Remote Terminal.

The SCAC main functions are:

- External stores configuration checks on the stores configuration data
- Control of the DU for 115V AC three-phase power distribution to the stores and store stations
- Monitoring of the current "A/C stores inventory" and transmission of the relevant data to FCS (in support of carefree handling) and to other avionic subsystems, e.g. IMRS for mission monitoring and D+C to display the data on the MHDD/STOR format
- Control of all weapons selection, arming, firing and release
- Selective jettison
- Emergency jettison of all applicable stores/ weapons
- Gun firing control and monitoring.

The SCAC interfaces with external equipment by means of:

- attack Bus to communicate with all AVS subsystems and other external systems (e.g. FCS, UCS, PRP)
- weapon Bus, to communicate with NSCAC
- transmit / receive signals subject to high integrity or high speed requirements (weapon arming, firing, jettison commands, store-on-station monitoring).

The SCAC interfaces are:

- Armament Control Elements (ACE), via dedicated links
- NSCAC, station units and stores, both via Weapon Bus and dedicated links
- DU, via Weapon Bus
- Tank Ejection Units, via dedicated links, direct for centre wing stations, passing through the FSU for the centre fuselage station
- Flight Control System (FCS), Digital Engine Control Unit (DECU), Attack Computer (AC) and Navigation Computer (NC), via Attack bus
- Landing Gear Computer (LDG), Armament Ground Test Switch (AGTS)
- Gun Control Junction Box (GCJB), via dedicated links.

Non Safety Critical Armament Controller (NSCAC)

The NSCAC performs the computation of ACS non safety critical aspects which include missile servicing, data handling and weapon priming and moding. The NSCAC is a two channel digital computing unit and controls the non safety critical functions of the ACS, receiving data from the Attack Bus and providing the relevant computations as required for the selected store. All store data are sent

to the Weapons/Station Units via the Weapon Databus.

The NSCAC exchanges data and control signals with the SCAC to support all store launch functions, except launch commands, via the Weapon Bus.

The NSCAC is a digital computing unit with a dual channel architecture, where one channel is active and the other is in hot stand-by (i.e. ready to takeover if the primary channel fails).

The NSCAC main functions are:

– Data bus controller (dual redundant) for the weapon bus
– All non-safety critical operations required by weapon/stores management, i.e.:
    - weapon priming data transfer to/from aircraft (A+I, NAV, FCS) via the Attack Bus
    - aiming data conversion from the aircraft main reference axis system to each applicable weapon local axis system and vice versa
    - subsequent aiming data transmission under control of the SCAC either directly to the weapon or through the relevant station unit
    - weapon stations harmonization process for weapons alignment control
    - weapon data receipt and processing from weapons / station units (status message from AMRAAM, operating seeker mode and position from SRAAM, etc)
    - DU control for Video (HB1, HB3) and Audio (LB1) signals routing / processing (e.g. to route the audio tone signal generated by the first SRAAM ready to be fired to the pilot headset for lock-on verification and consent)
    - collection of all ACS LRIs health status and maintenance data from station units and launcher electronic units for subsequent transmission to IMRS.

The NSCAC interfaces with external equipment by means of:

– attack Bus to communicate with all AVS subsystems (e.g. A+I, NAV, IMRS) and other external systems (e.g. FCS)
– weapon Bus to communicate with all ACS LRIs, missile launchers Electronic Units and weapons/stores with STANAG-1760 communication protocol.

The NSCAC main interface is with the SCAC, via Weapon Bus, as required to support all stores operations (except for direct release / firing commands).

Other NSCAC interfaces on the Weapon Bus are:

– all Station Units and Stores, to support stores operations and monitoring
– DU, to control video and audio signals routing.

NSCAC interfaces on the Attack Bus are:

– Flight Control System (FCS), Attack Computer (AC), Navigation Computer (NC), to support missile priming and harmonization processes
– Interface Processing Unit (IPU), for ACS monitoring and maintenance support.

Master Armament Safety Switch (MASS)

This is a three position rotary switch. The selectable positions are the following:

– SAFE. With this selection it is not possible for the ACS to perform any functions
– STBY. With this selection all functions of the ACS are enabled with the exception of arming, release, firing and jettison
– LIVE. This position enable all the ACS functions.

Armament Safety Break Contactors (ASBC)

These two power relays supply the 28 V DC fire to the selected Station Units and are activated by the SCPI (Safety Control Power Initiate) signal coming from the SCAC (after pilot fire request).

Distribution Unit (DU)

The DU is a dual channel LRI with a double remote terminal interface on the Weapon Bus. It acts as a switching box to perform the following two main functions:

– Distribution of 115V AC three-phase electrical power to the stores fitted on the 13 store stations. This function is carried out under direct control of the SCAC that commands the DU (via Weapon Bus) to switch the proper relays within the ACS Bus Bar Box
– Routing of MIL-STD-1760A CLASS II signals (LB and HB lines) between the stores fitted on any store station and the AVS subsystem. This function is carried out under direct control of the NSCAC and presently is limited to the routing of the audio tone of the first SRAAM that is ready to be fired to the pilot head set. For this purpose the DU:
    - receives each missile audio tone via a discrete HW line
    - performs an A/D conversion of the signal in order to filter it with respect to the audio level threshold input from the NSCAC and communicates the results to the NSCAC via Weapon Bus
    - routes the analogue signal of the best available missile (as indicated by the

NSCAC) to the pilot headset via a dual discrete HW link with the Communication and Audio Management Unit (CAMU)

– No Video signal processing function is presently required.

Fuselage Station Unit (FSU)

The FSU is a dual channel LRI with a double remote terminal interface on the Weapon Bus. It provides the interface for the 5 fuselage store stations, controls and monitors the Ejection Release Unit (ERU) of the centre fuselage pylon, the TEU of the Supersonic Fuel Tank (SFT) and the 4 Missile Ejection Launchers (MEL) to support release/jettison capabilities of the relevant stores. All discrete inputs from the stores interface are acquired by both FSU channels and the relevant information are transmitted via Weapon Bus to both SCAC and NSCAC via the selected RTs. The SCAC provides the FSU with 5 independent release consent signals (one for each store station) and another 5 independent jettison signals via dedicated HW links (duplex hardwire lines); for weapon release, further SCAC commands via Weapon Bus are required. Once initiated by the proper SCAC commands, the FSU generates all the outputs necessary to complete the release/jettison of each store, controlling the due signal output sequence and timing. For each of the 5 store stations, jettison functions are fully duplicated and separately powered from two different power supplies.

Wing Pylon Station Unit (WPSU)

A WPSU is installed within each outboard, centre wing pylon: it is a single channel LRI with a single remote terminal interface on the Weapon Bus. The WPSU provides the interface between the aircraft and the store/weapon or carrier/launcher fitted on the corresponding wing store station: it controls and monitors the ERU to support release/jettison capability as applicable. The SCAC provides the WPSU with a discrete signals (release consent and jettison) via dedicated HW links (duplex hardwire lines); for weapon release, further SCAC commands via Weapon Bus are required. Once initiated by the proper SCAC commands, the WPSU generates all the outputs necessary to complete the release/ jettison of the store, controlling the due signal output sequence and timing. Jettison functions are fully duplicated and separately powered from two different power supplies.

Integrated Tip Station Unit (ITSU)

An ITSU is a single channel LRI with a single remote terminal interface on the Weapon Bus which is integrated within each wing tip stub pylon of the aircraft. The ITSU provides the interface between the aircraft and the SRAAM fitted on the ITSPL: it controls and monitors the relevant electromechanical devices (missile detention and cooling mechanisms) to support the release capability. The ITSU also includes dedicated electronics to perform the A/D conversion of the analogue line-of-sight signals generated by the missile IR seeker for the NSCAC and vice-versa the D/A conversion of seeker slaving data generated by the NSCAC for the missile aiming.

Armament Controls

ACS functions can be either controlled by the pilot/ ground-crew or by safety critical inputs from external systems/subsystems. The pilot controls are all located in the cockpit; all remaining ACS Controls are reported in the following:

Weight-On-Wheels (WOW). The WOW HW signals are generated by two double pole changeover switches fit within the main landing gear mechanism and directly wired to the SCAC via dedicated HW links (duplex hardwire lines). On receipt of such discrete signals, the SCAC inhibits the firing/release functions while the aircraft is on ground: only Emergency Jettison is not affected by WOW.

Armament Ground Test Switch (AGTS): this is a double pole changeover switch located in the right main landing gear bay, used to override the WOW signals interlock for ACS ground testing purposes.

Landing Gear Up Lock switches. These switches are located in each of the three LG mechanisms. They provide information about the present state of the left and right Main LG wheels (Up/Down) and of all LG doors (Closed/Open). Such HW signals (bridged to the SCAC by LG Computer via dedicated HW lines) are used to inhibit:

– release/firing of the external stores from the fuselage ejector launchers, when the main gear is not up-locked
– missile firing from the fuselage stations, when the nose gear is not up-locked.

Store on Station switches. These switches are located on the mechanical interface with the stores (pylons ERUs and MFRLs, fuselage MELs) and wired to the SCAC via duplex hardwire lines: such signals are used by the SCAC to monitor the presence of the relevant stores and/or store carriers.

Functional Description

The ACS supports the following main functions:

– Weapons and stores configuration monitoring
– Stores jettison
– Weapon management
– ACS Built-in Test (BIT).

Weapons and Stores Configuration Monitoring

The External Stores Configuration data are input to the SCAC via two different external sources: one set of data is programmed by the ground crew on the Maintenance Data Panel (MDP) and the other is loaded as part of the mission data via the Portable Data Storage (PDS) or the Ground Loading Unit (GLU as a back-up source). Both data sets are input to the UCS bus, the Interface Processor Unit (IPU) and then to Attack Bus. These two sets of data are only accepted with Weight-On-Wheels set to "True". The pre-flight operation includes the power-up BIT, the configuration checks and the inventory validation.

P-BIT

The P-BIT is started on ground by setting the MASS to STBY and includes all ACS electronic equipment start-up checks.

Configuration Checks

The configuration checks are carried out by the SCAC on ground after ACS P-BIT completion. Both data sets are received from the ATK bus and undergo two different validity check: integrity checks (verification of consistency with the system design and specification requirements) and symmetry checks (L/R wing, F/R fuselage stations). If both data sets are available and valid then they are cross-checked by the SCAC. If no discrepancies is detected, the stores configuration data is accepted and displayed on the MHDD/STOR format. If either data sets are not available when requested by the SCAC or one of the two sets is not valid but:

– at least one of the two is available and valid or
– both sets are available but not consistent with each other

then the ACPT/RJCT soft key on MHDD/STOR format is activated and the pilot intervention is required (SCAC operation; are suspended).

Inventory Validation

The SCAC starts the inventory validation after the stores configuration checks have been successfully completed. The process is carried out station by station and it consists of two groups of checks: compatibility and serviceability. The compatibility checks verify the consistency between the loaded stores and the assigned stores configuration. The serviceability checks ensure, where possible, if each store is ready to be used thus enabling all support functions required to reach the operational conditions.
If no errors have been detected at the end of the compatibility checks, the SCAC performs the serviceability checks, where required, or continues the validation on the next station in the pre-defined sequence. If any errors have been detected the SCAC removes all kind of electrical power applied to that station, sets the relevant H.P. status to "UNKNOWN" and continues the validation. When the process has been completed the SCAC transmits the following data:

– present store state to the FCS
– store availability to the displays and controls system
– present store state and availability to the IMRS.

If a store though present is not available, a proper symbol will be shown on MHDD/STOR format.
If the hard point (HP) state results “unknown” in more than one station the FCS reduce the take-off and flight envelopes, and the SCAC will inhibit all firing and release functions with the exception of emergency jettison and gun firing. This state can only be recovered by recycling the MASS (STBY / SAFE / STBY) after the problems detected during the inventory validation process have been solved.

Stores Jettison

Emergency Jettison

To initiate the Emergency Jettison (EJ) the pilot shall:

– set the MASS in "LIVE" position
– press the EMGY JETT pushbutton (located in the left quarter panel).

Following such operation, the SCAC interrogates the EMGY JETT pushbutton for validity logic to verify the depression length of time and both the normally-open and normally-closed signals from the pushbutton: this is made to avoid the possibility of EJ being caused by spurious pulses.
On receipt of a valid EJ signal, the SCAC removes any electric power that is possibly applied at that very moment to the weapons/stores which are going to be jettisoned and commands the EJ sequencer to perform the jettison of all applicable stores in a pre-defined sequence; the time interval between each individual store jettison is pre-defined as well. The whole process is controlled via a HW logic: as such it does not depend on the present stores configuration and once initiated cannot be stopped nor modified.
When the EJ process is initiated, each ACS Station Unit involved is commanded in turn by the SCAC to connect both the HW jettison command and the 28V DC fire power supply lines through to the relevant ACIS LRI (ERU, TEU or MEL). Within the ACIS LRI, the jettison command closes an isolation circuit that allows the 28V DC fire power supplies to detonate the relevant Electric Explosive Device (EED, i.e. cartridges) and perform the jettison operation.

Selective Jettison

When a Selective Jettison (SJ) operation is carried out only those stores/weapons that have been chosen among all applicable ones and included in a valid SJ Package are jettisoned.
To initiate the Selective Jettison (SJ) the pilot shall:

– check the SJ package presently available
– check the MASS in "LIVE" position
– press the SEL JETT pushbutton (located in the left quarter panel).

Following such operation, the SCAC interrogates the SEL JETT pushbutton for validity logic (the same applied to the EMGY JETT pushbutton for EJ). On receipt of a valid SJ signal, the SCAC removes any electric power that is possibly applied at that very moment to the weapons/stores which are going to be jettisoned and commands the jettison operations of the chosen stores. The jettison sequence for SJ is fully controlled by the SCAC SW: it is determined and continuously re-assessed with respect to the overall aircraft mass balance requirements, i.e. it depends on the configuration of the stores present on board at that very moment and as such it can be modified or even stopped by adverse events (e.g. hang-up). On the other side, the time interval between each individual store jettison is fixed (300 ms). The terminal processes implemented in each store station for the SJ of the relevant store/weapon are the same already detailed above for EJ.

Weapon Management

SRAAM Management

The ACS supports full weapon management of AIM-9L missiles.
SRAAM management is supported for missiles fitted on both the ITSPL on the wing Tip Stub stations and the MFRL on the wing Outboard stations.
When the stores configuration checks on ground are finished the ACS starts supporting the SRAAM basic functions. In particular the ACS supports each missile IR seeker cooling by providing the 115V AC three-phase power to the relevant cooling mechanism (HiPPAG), and 28V DC power to the logic control unit and controlling it via Weapon Bus commands. The SRAAM cooling is activated if:

– the MASS is set to "STBY" and SRAAM has been selected
– the MASS is set to "LIVE".

The weapon type selection can be made in two ways:

– manually, by the pilot, via the A-A Weapon selector located on the Stick Top (centre downward push)
– automatically, by AVS request to ACS when a target is acquired by A+I sensors and no other A-A weapon is selected.

The ACS is responsible for the selection of the individual weapon to be fired, taking into consideration the mass balance requirements and the seekers operational status (audio tone level, line of sight, target obscuration). When the ACS has determined the best SRAAM available for firing then the relevant audio tone is routed to the head-set of the pilot, who can still reject it (e.g. because of the audio signal poor quality); in this case a new SRAAM station will be evaluated by ACS and proposed to the pilot as the next weapon to be fired. The reject button is located on the throttle top.
The SRAAM seeker can be either Caged (i.e. forced to aim at a definite direction in space as commanded by the system under ACS control) or Uncaged (i.e. free to move following the IR sources caught within its field of view, under control of the missile own avionics).
When Caged, the seeker is normally slaved to ACS slaving controls that depend on the seeker mode chosen by the system at that moment; three modes are available:

– BORESIGHT, when the seeker is aligned along aircraft X-axis boresight
– SLAVED TO TARGET, when priming data are originated by A+I sensors (i.e. RADAR and FLIR, when available)
– MANUAL, when priming data are originated by A+I on direct input from the pilot via X-Y Controller.

The SRAAM seeker mode is selected by ACS, depending on the pilot request, the available target data sources and the operational conditions. The pilot request is made by depressing recursively the A-A weapon selector in the centre position; the pre-defined sequence is: BORESIGHT / STT / MANUAL. A default seeker mode is assigned at weapon type selection: BORESIGHT for the manual selection, STT for the automatic selection.
The SRAAM seeker is uncaged by ACS to allow it to lock-on the target, once it has been properly acquired. Such condition is determined by the ACS, also depending on the seeker mode used to track the target and/or on the input got from the pilot, i.e.:

– when in STT mode the SRAAM is uncaged without pilot intervention, as soon as the ACS has determined that the target is not obscured, the line of sight is aligned to A+I priming data and the audio tone is good; the pilot can re-cage the seeker manually, if required by combat operations
– when in BORESIGHT or in MANUAL mode, the ACS still performs some checks on the seeker

target acquisition status but waits for the pilot command to uncage it.

The pilot can command to uncage / re-cage the seeker by toggling the A-A weapon selector on the stick top to the centre right position.

When the pilot intends to fire a SRAAM, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC:

– commands the ASBCs to route the 28V DC 2 Fire Power to all available SRAAM stations
– commands all SRAAM launchers (via Weapon Bus) to unlock the relevant In-Flight Operable Lock (IFOL).

If any station fails to unlock then that station is declared unavailable; if the first station selected for firing has failed then a new station is selected. When the pilot presses the Trigger the SCAC performs the final Safety Interlock Checks: if the MASS is in "LIVE" position, the aircraft is in flight, the Late Arm is armed and the selected SRAAM station IFOL is unlocked, then the Release Consent discrete signal is sent to the ITSU or MFRL (as applicable) followed by the data bus command to initiate the SRAAAM firing sequence. At that point, as soon as the missile battery has become active and the missile is ready to be fired, the ITSU / MFRL outputs the Motor Fire signal to ignite its rocket motor.

AMRAAM Management

The ACS supports full weapon management of AMRAAM missiles; this applies to missiles fitted on both the MEL on the 4 Fuselage shoulder stations and the single MFRL on the Wing Outboard stations. Most of the ACS functions dedicated to AMRAAM are fully transparent to the pilot, who can therefore concentrate on combat operations. The weapon type selection can be made by the pilot via the A-A Weapon selector located on the Stick Top (forward push).

The ACS is responsible for the actual selection of the individual weapon to be fired, following a sequence that takes into consideration the mass balance requirements and the weapon operational status. The latter can be "GOOD", "DEGRADED" or "UNSAFE TO LAUNCH", as determined by the SCAC during the serviceability checks that are carried out on ground at the end of the store configuration checks, and it is recorded within the relevant missile Health Status message.

AMRAAM priming processes are mainly controlled by A+I: the Attack computer makes use of sensors inputs and pilot indications to compute the targeting and uncertainty data. Such data are then sent to ACS (via Attack Bus) and routed to the missile (via Weapon Bus). The most significant function carried out by ACS for AMRAAM priming is the Harmonization process of each weapon station, consisting of the correction of the direction cosines matrix operated by the NSCAC before transmitting it to the missile as part of the targeting data message. AMRAAM priming only takes place during the final missile firing sequence. In fact, at the end of serviceability checks all electric power supplies to AMRAAM are removed and the missiles are carried in flight like inert stores until the pilot requests the launch of the first missile in sequence.

When the pilot intends to fire an AMRAAM, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC:

– commands the ASBCs to route the 28V DC 2 Fire Power to all available AMRAAM stations
– if there are AMRAAM missiles fitted on the Wing Outboard stations, commands both launchers (via Weapon Bus) to unlock the relevant In-Flight Operable Lock (IFOL). If any station fails to unlock then that station is declared unavailable; if the first station selected for firing has failed then a new station is selected.

When the pilot presses the Trigger the SCAC performs the final Safety Interlock Checks: if the MASS is in "LIVE" position, the aircraft is in flight, the Late Arm is armed and the selected AMRAAM station IFOL (if applicable) is unlocked, then the Release Consent discrete signal and the 115V AC power are sent to the missile and the AMRAAM Launch Events Sequence is triggered. During such sequence the following events occur:

– the NSCAC wakes up the missile and synchronizes it with the aircraft time
– the missile replies to the system with wake-up confirmation
– Targeting and Uncertainty Data messages are sent to the missile for priming
– the missile confirms it has correctly received priming data and is ready to launch.

At the end, if no failure interrupts the sequence, the SCAC removes the 115V AC power and sends to the relevant station the "AMRAAM LAUNCH" or "AMRAAM EJECT" final command causing either the MFRL umbilical retraction mechanism activation or the MEL umbilical disconnection by ejection, as applicable. Following the umbilical disconnection the AMRAAM rocket motor is ignited after a short time gap (that depends on the type of launcher used).

GUN Management

The ACS supports full GUN management, i.e. mainly:

– available gun rounds monitoring
– gun firing control
– gun re-cocking (following a cartridge misfire).

The GUN selection can be made by the pilot via the A-A Weapon selector located on the Stick Top (backward push). The GUN interface with the ACS is represented by the Gun Control Junction Box (GCJB), a GUN system LRI fully controlled and monitored by the SCAC via discrete lines.
When the pilot intends to fire with the GUN, the Late Arm switch has to be moved to the Armed position and the Trigger must be pressed. As a consequence of Late Arm operation, if the MASS is in "LIVE" position and the aircraft in flight, then the SCAC provides the 28V DC 2 Fire Power to the Gun ammunition box to activate the gun rounds loading operations. After 100ms, the actual firing sequence can be activated with a (short) TRIGGER press. Both Trigger changes of state (Press and Release) are monitored by the SCAC to determine the length of the burst. FCS, PRP and DASS are timely informed that GUN firing is due/on-going. There are no absolute limitations to the maximum number of GUN rounds that can be fired in a single burst.
When the GUN control requirements are not fulfilled and such event is detected:

– the "GUN FAIL" warning is generated and GUN firing is inhibited
– failure and maintenance data are sent to IMRS for recording.

Gun firing can be inhibited just for the single burst (e.g. pulse-to-pulse incorrect timing) and then enabled again for a subsequent firing trial. On the other hand, if the SCAC detects own internal failures relevant to the GCJB interface then the GUN firing is inhibited indefinitely.

Weapon Stations Harmonization

The ACS support full weapon stations harmonization. The ACS harmonization process overcomes the problems caused by missiles misalignment with respect to its own theoretical position on board. Missile misalignment can be caused mainly by:

– store station and launcher installation on aircraft (Ground Static misalignment), which are measured (Ground Static Data)
– continuous aircraft in-flight maneuvers (Flight Static misalignment) that are mathematically modeled (Flight Static Data).

The ACS Harmonization process is carried out by the NSCAC that makes use of:

– Ground Static Data, loaded via IPU
– Flight Static Data, directly input with the application SW
– Current Flight Data, input during flight from FCS, NAV and A+I.

This process generates Harmonization Correction data used to modify the missile targeting data. For SRAAM priming, these data are used when providing the seeker sight line from the missile before routing them to D+I and vice-versa to convert priming data generated by A+I into slaving signals for the missile seeker. For AMRAAM priming these data are simply used to modify the direction cosines matrix sent to the missile.
The harmonization process is completely transparent to the pilot. Harmonization is provided for all wing missile stations (Tip and Outboard) and fuselage stations.

ACS Built-in Test (BIT)

The ACS Design includes several types of BIT, applicable to different operational conditions.

Power-Up BIT (P-BIT)

Started on ground by the pilot, setting the MASS to "STBY". Includes all ACS electronic equipment start-up checks.

Continuous BIT (C-BIT)

Runs continuously, since P-BIT completion. It is monitored by the SCAC SW. It Includes all ACS and ACIS electronic equipment C-BIT, plus the monitoring of ACIS and GUN non-electronic LRIs interfacing ACS.

Initiate BIT (I-BIT) Type 1

This is the most complete ACS BIT available. It is run on ground only by pilot request from the MHDD/ ACUE format (select "ACS" and then, when page 2 is displayed, select "IBIT" soft key). This BIT includes checks on all ACS and ACIS electronic equipment, with the exception of DU and Armament Control Elements. It can be performed with weapons loaded on aircraft stations.

Armament Safety System

(1B-B-94-70-00-00A-111A-A Issue 003)

The Armament Control Sub-system (ACS) is operated by controls and indicators located in the cockpit as described in the following:

– Master Armament Safety Switch (MASS) (Figure 1.318 front cockpit)
– SCAC Norm/Rev Switch (Figure 1.318 front cockpit)
– EMGY JETT Pushbutton (Figure 1.318 front cockpit and Figure 1.319 rear cockpit)

- SEL JETT PROG/TANKS Switch (Figure 1.318 front cockpit)
- SEL JETT Pushbutton (Figure 1.318 front cockpit and Figure 1.319 rear cockpit)
- WEAPON TRAINING Switch (Figure 1.318 front cockpit)
- WEAPON RELEASE ENABLE/INHIBIT Switch (Figure 1.319 rear cockpit)
- HOTAS Controls (Figure 1.320)
- SRAAM XFOV key (MHDD/ATCK Format)
- HUD Format on both HUD and MHDD/HUD
- MHDD/STOR Format (Figure 1.321).

Master Armament Safety Switch (MASS)

The Master Armament Safety Switch (MASS) is located on the front cockpit right console.

This three position switch permits the following selections:

- SAFE - In this position the MASS isolates the ACS from all electrical power
- STBY - In this position the MASS isolates the power required by the ACS for safety critical functions (arming, release, firing and jettison); in the STBY position, power is available to the logic elements of the ACS units, to allow all computation and control functions to operate
- LIVE - In this position all the required power supplies are made available to the ACS.

Selection of the MASS LIVE position is mechanically protected such that the control top has to be raised (pulled) in the direction of the control shaft during the clockwise selection from STBY to LIVE. Only one of the legends is visible at any one time, the remaining two are completely obscured by the control top.

The Display and Controls Sub-system (D+C) is able to sense MASS position. Depending on the constraints of the D+C, a MASS SAFE / STBY / LIVE indication will be displayed on the MHDD/STOR format.

SCAC Switch

The SCAC NORM/REV switch is located on the front cockpit left console.

This two position toggle switch is locked in both forward and aft positions and must be unlocked by pulling in the direction of the control shaft prior to selection of either position. It provides the following functions:

- NORM - The SCAC operates in dual channel mode
- REV - The SCAC operates in single channel mode.

EMGY JETT Pushbutton

This pushbutton is identified by the legend “EMGY JETT” surrounded by a raised barrier.

It is located on front and rear cockpit left quarter panel.

Upon selection of the pushbutton with the MASS in LIVE position (unless the BATT switch is selected to the OFF position) the ACS generates the outputs necessary to jettison all applicable stores/weapons from the aircraft in a fixed sequence. The ACS on receipt of EJ initiation demand, initiates the jettison of all allowable stores in a fixed pre-defined sequence; the time interval between each individual store jettisonable is pre-defined as well.

SEL JETT PROG/TANKS Switch (Not Operative)

This two position bi-stable toggle switch is locked in both the forward and aft positions and must be unlocked prior to selection to avoid inadvertent operation.

It is located on the front cockpit left quarter panel.

The switch is used in conjunction with the SEL JETT pushbutton. The purpose of the control is to enable the aircrew to jettison either the stores in a predetermined sequence or drop tanks in isolation.

The switch provides the following functions:

- PROG - The jettison of all weapon stations designated either by MHDD/STOR or down loaded by the PDS is enabled
- TANKS - The jettison of the tanks is enabled.

SEL JETT Pushbutton

This pushbutton is surrounded by a raised barrier and it is located on front and rear cockpit left quarter panel.

Upon selection of the JETT pushbutton with the MASS in LIVE position the ACS generates the appropriate sequence of jettison signals for the selected store(s)/weapon(s) only, i.e. only those weapons/stores identified in the validated SJ package will be jettisoned taking into account the requirements for the aircraft mass balance and safe separation.

WEAPON TRAINING Switch (Not Operative)

This two position bi-stable switch is locked in both the forward and aft positions and must be unlocked prior to selection to avoid inadvertent selection.

It is located on the front cockpit left console.

The switch provides the following functions:

- LIVE - The normal weapon release is enabled
- TRAIN - The weapon release is inhibited.

WEAPON RELEASE ENABLE/INHIBIT Switch

This two position bi-stable switch is locked in both the forward and aft positions and must be unlocked prior to selection to avoid inadvertent selection.
The switch is located on the rear cockpit left console and provides the following functions:

– INHIBIT - Any weapon release is inhibited also from the front cockpit
– ENABLE - The weapon release is allowed by either front or rear cockpit. This is dependent upon which cockpit has the control.

HOTAS Controls

ACS functions are also controlled via HOTAS controls, to allow a rapid weapons management under all conditions. The HOTAS controls are described in the following subparagraphs and shown in Figure 1.320.

Air to Air Weapon Trigger and HUD Camera

Pressing the Air to Air Trigger and HUD Camera to the first detent runs the Video/Voice Recorder (VVR) if not already running. Pressing to the second detent fires the selected weapon if an AAM or the Gun is selected. The second detent can only be reached if the Late Arm is in the armed position.

Late Arm Safety Interlock (LAS)

The Late Arm Safety Interlock enables the Weapon Commit/Release control and Air to Air Trigger operation.
The LAS is a two position (SAFE/ARMED) slider type control. With the control set to the safe position, it both inhibits the electrical function and prevents the mechanical selection of the trigger and the Weapon commit/release control. It also provides an interlock to prevent weapon arming /fuzing.
Selection of the ARMED position (indicated by exposing an orange marker) enables the functions of both the Trigger control and the Weapon Commit/ Release control. Selection of the armed position also removes the mechanical detent of both controls and removes the arming /fuzing interlock.
The Late Arm Safety Interlock switch is fitted to both the front and rear cockpits sticks tops. The late arm function is only available in the front cockpit. Selection of the Late Arm on the rear cockpit stick top is only a mechanical operation and does not enable or inhibit weapon release from the front cockpit.

Air to Air Weapon selector

The Air to Air Weapon selector is used to select the Air to Air weapons.
The Air to Air Weapon selector is a six position toggle switch which enables selection of MRAAM (forward selection), air-to-air gun (aft selection) and SRAAM (center push selection). Repeated selection of SRAAM enables sequential selection of the SRAAM priming modes (slaved to sensor and manual).

Air to Surface Weapon Commit/Release Control

The Weapon Commit/Release control is used to release the pre-selected air-to-surface Weapon Package.

SRAAM reject button

The SRAAM reject button, is used to reject the currently selected SRAAM missile and select the following in the sequence.

X-Y Controller

The X-Y controller is used for:

– build a new SJ package
– control SRAAM seeker head when SRAAM manual mode is selected.

SRAAM XFOV key

This is a soft key, available to the pilot on the MHDD when the ATCK format is displayed: when pressed, it enables the AIM–9L seeker scan mode i.e. the seeker is slaved to a circular pattern that is superimposed on the normal seeker slaving track (as determined by the priming mode currently in use) effectively extending its physical field of view.

MHDD/STOR Format

The STOR format, provides a diagrammatic representation of weapon system status and current stores configuration. The STOR format also displays the MASS state, number of remaining gun rounds and "SEL JETT NOT ACCEPTED" caption, when the SJ package input to the ACS has been checked and rejected by the SCAC so that SJ is not available. The SK on the STOR format are described in Table , “MHDD/STOR Format Soft Keys,” on page 1-610.

MHDD/STOR Format Soft Keys

SOFT KEY	FUNCTION
W	Selects the Warning Procedures format for display (inoperative)
STOR	Selects the Weapon Configuration/ Selective Jettison format
HYD	Selects the Hydraulic format
FUEL	Selects the Fuel format
WPT	Selects the waypoint/airfield list format for display (inoperative)
ENG	Selects the Engines format
NO WPN	Deselects the selected weapon
ELEV	Selects Elevation format
FREQ	Selects Radios format
NORM	Selects Default format
DASS	Selects Defensive AIDS Sub-system format
HUD	Selects Head Up Display format

Weapons Selection

An indication of weapon selection is provided in the bottom left corner of the HUD and MHDD/PA format. The letters M, S and G are used to indicate selection of MRAAM, SRAAM and gun respectively. Each letter is suffixed by a number denoting the quantity of stores/rounds available of that particular type. In addition, for SRAAM only, it is also indicated in brackets the number of rejected missiles.

Dedicated Warning Panel (DWP)

Information on specific ACS failures or abnormal conditions are displayed on the DWP and are presented to the pilot as follows:

– **ACS FAIL** Warning Category 3 in all POF.
The consequences on the system functioning are: loss of store control except the Emergency Jettison and loss of external store mass data supplied to FCS

– **DU FAIL** Warning Category 3 in all POF.
The consequences on the system functioning are: loss of 3 phase to the stores, loss of weapon functions related to HB1, HB3, LB lines and no tone for AIM-9L

– **NSCAC** Warning Category 3 in all POF.
The consequences of automatic selection of NSCAC reversionary modes and further NSCAC failures will cause the loss of store control functions except Emergency Jettison

– **SCAC** Warning Category 3 in all POF.
The consequences on the system functioning are: loss of store control except the Emergency Jettison and stores mass data to FCS

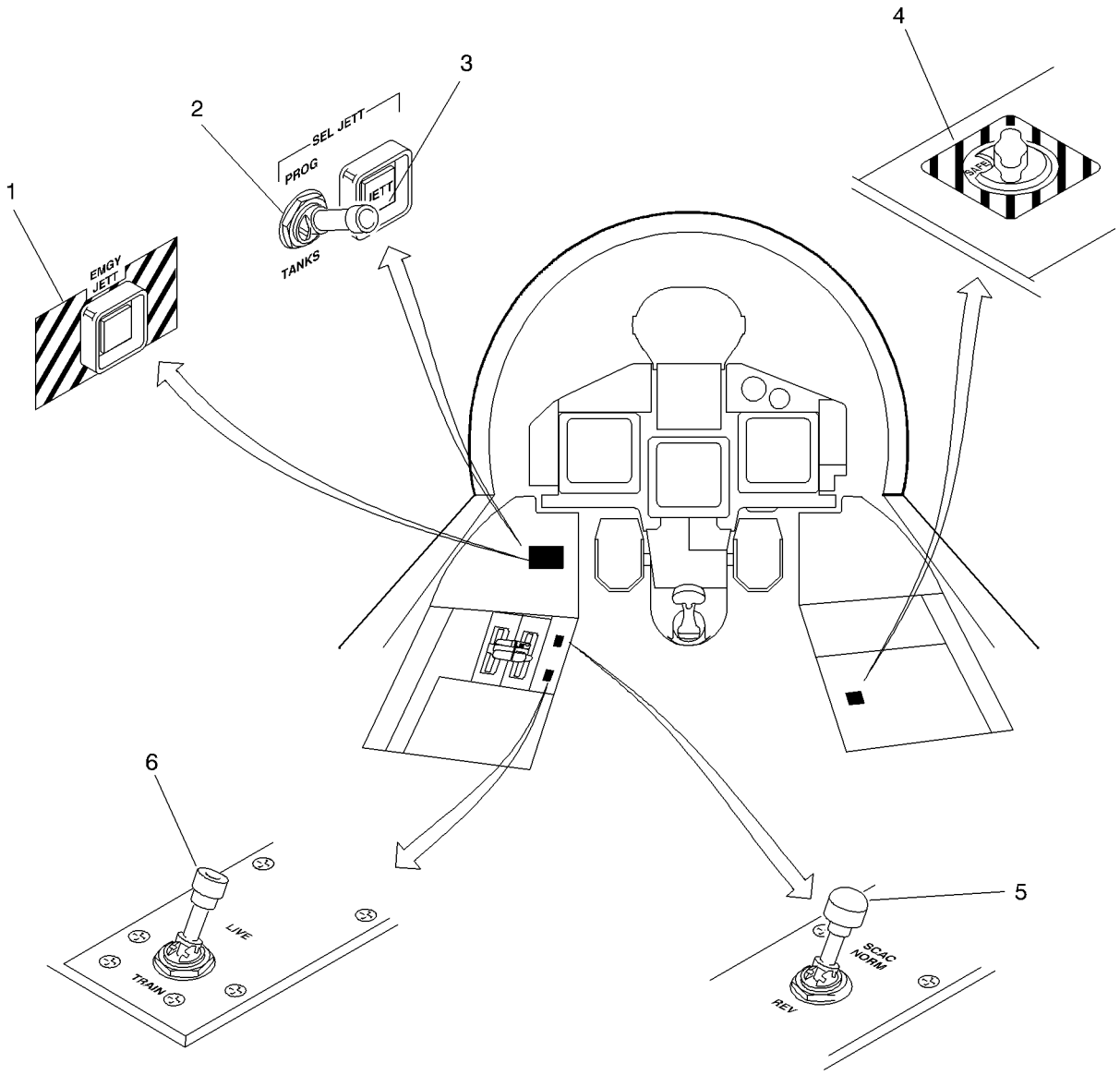
– **HANG UP** Warning Category 3 in all POF (except on GND when it is not available). When a weapon/store has failed to separate following a jettison or firing command

– **EJ FAIL** Warning Category 3 in all POF.
The consequence on the system functioning is the loss of emergency jettison function

– **SJ FAIL** Warning Category 3 in all POF.
The consequence on the system functioning is the loss of selective jettison function.

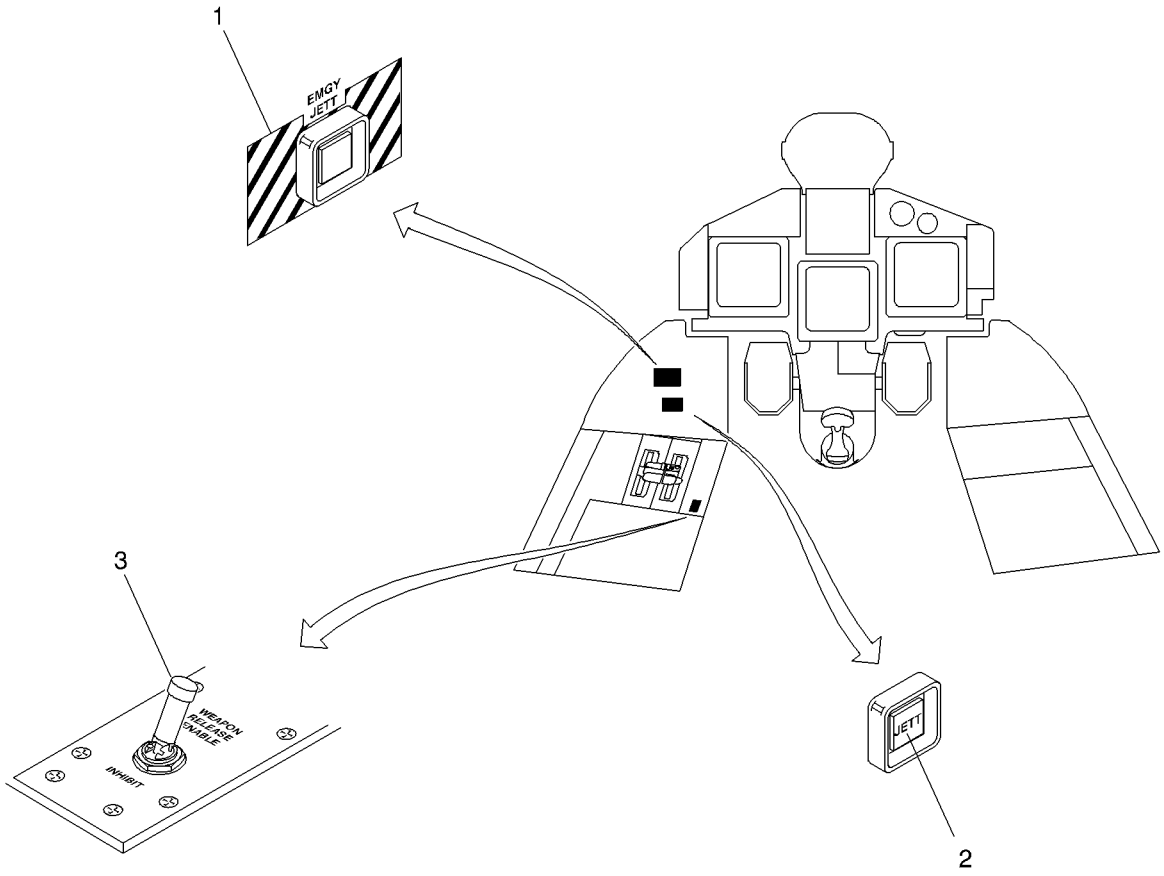
Dedicated MASS Status Voice Warning

The voice warning message “MASS NOT LIVE” is a warning category 4 (except on GND when it is not provided and on T/O when its category is 1) and no dedicated caption appears on DWP.
The voice warning “MASS NOT LIVE” is heard by the pilot in the headset when in T/O the Master Armament Safety Switch (MASS) is not set in LIVE position and the throttles are advanced to a position above the 80% NL.



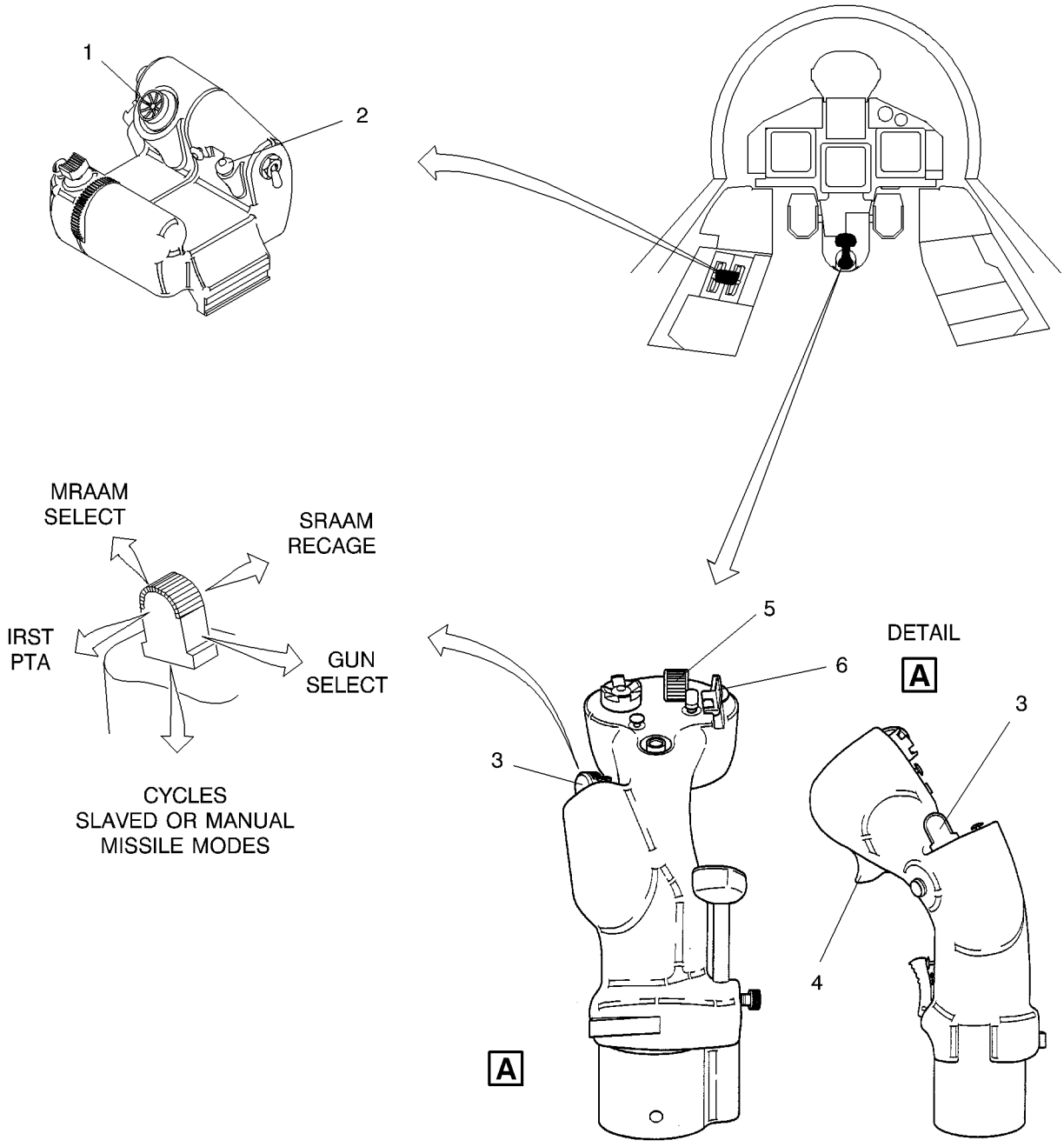
1 EMGY JETT PUSHBUTTON
2 PROG/TANKS SWITCH
3 JETT PUSHBUTTON
4 MASTER ARMAMENT SAFETY SWITCH
5 SCAC NORM/REV SWITCH
6 WEAPON TRAINING SWITCH

Figure 1.318 - Controls and Indicators



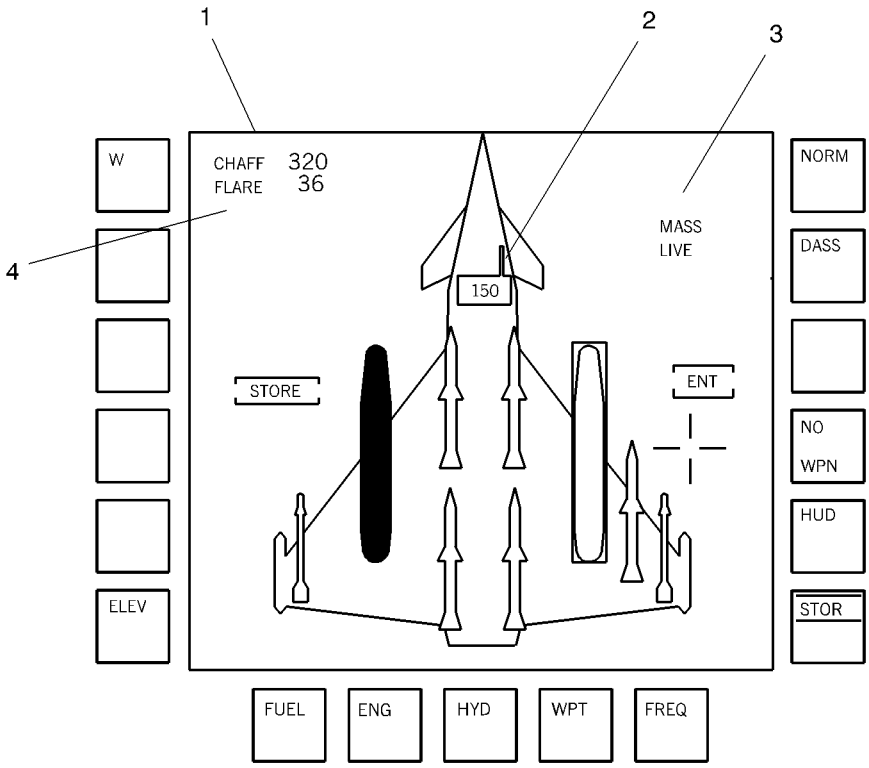
1 EMGY JETT PUSHBUTTON
2 JETT PUSHBUTTON
3 WEAPON RELEASE ENABLE/INHIBIT SWITCH

Figure 1.319 - Controls and Indicators (Rear Cockpit)



1 X-Y CONTROLLER
2 SRAAM REJECT BUTTON
3 AIR-TO-AIR WEAPON SELECTOR
4 HUD CAMERA/AIR-TO-AIR TRIGGER
5 LATE ARM SAFETY INTERLOCK
6 WEAPON COMMIT/RELEASE CONTROL

Figure 1.320 - HOTAS Controls



1 REMAINING CHAFF
2 GUN REMAINING ROUNDS
3 MASS STATE DISPLAY
4 REMAINING FLARE

Figure 1.321 - MHDD/STOR Format

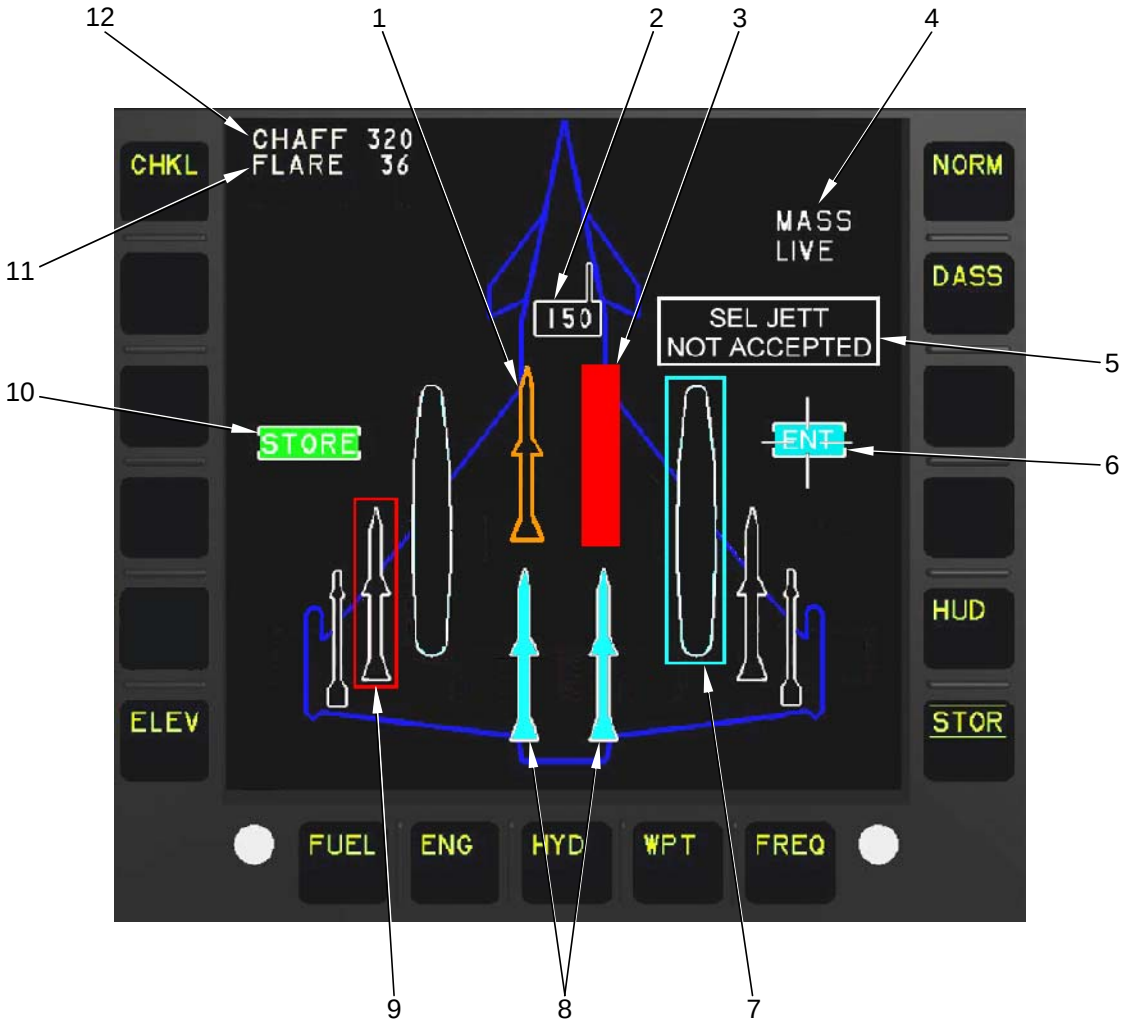
Stores

(1B-B-94-10-00-00A-111B-A Issue 003)

Stores Format

The Multifunction Head down Display Stores format (MHDD/STOR) is automatically displayed on the ground on the right MHDD when the MASS is set to STBY or LIVE. It can also be selected via a soft-key from other MHDD formats (Figure 1.322).
An indication of the store type is displayed for 7 seconds on initial selection of the stores format when the MASS is set to STBY or LIVE (Figure 1.323). Store type may subsequentley be displayed by performing an X-Y insert over the STORE legend on the format. When the X-Y marker is moved off the STORE legend, all stores legends are immediately occulted.
The stores format graphically displays the location of externally mounted fuel tanks and weapons, and the remaining number of gun rounds, chaff and flares. The pilot can preselect any external stores for subsequent selective jettison, using the X-Y marker and/or mission data loaded through the PDS; the store symbology on the MHDD/STOR format shows the status of any store, from selective jettison preselection, hung stores, inhibited stores and degraded stores. The format also shows MASS position, and the status of the selective jettison preselection.
Stores indications are also given when (not illustrated):

– All stores inhibited; indicated by a red cross in the center of the display
– An autocue no go and caution; indicated by NOGO and CAUTION on the display
– Fuel transfer is in progress; indicated by FUEL XFER on the display
– Emergency ram air profile change; indicated by ERA PROF on the display
– Breakaway indication; a large white St Andrews cross in the center of the display



1 STORE DEGRADED INDICATION
2 GUN ROUNDS REMAINING
3 INHIBITED STORE INDICATION
4 MASS STATUS INDICATION
5 SELECTIVE JETTISON NOT ACCEPTABLE INDICATION
6 SELECTIVE JETTISON PROGRAM ENTER SYMBOL
7 SELECTED FOR SELECTIVE JETTISON INDICATION - FLASHES IF NOT ACCEPTABLE ON X-Y INSERT OVER ENTER SYMBOL
8 STORES IN SELECTIVE JETTISON PROGRAM
9 HUNG STORE INDICATION
10 STORE TYPE DISPLAY SYMBOL
11 FLARES REMAINING INDICATION
12 CHAFF REMAINING INDICATION

Figure 1.322 - Stores Format - Indications

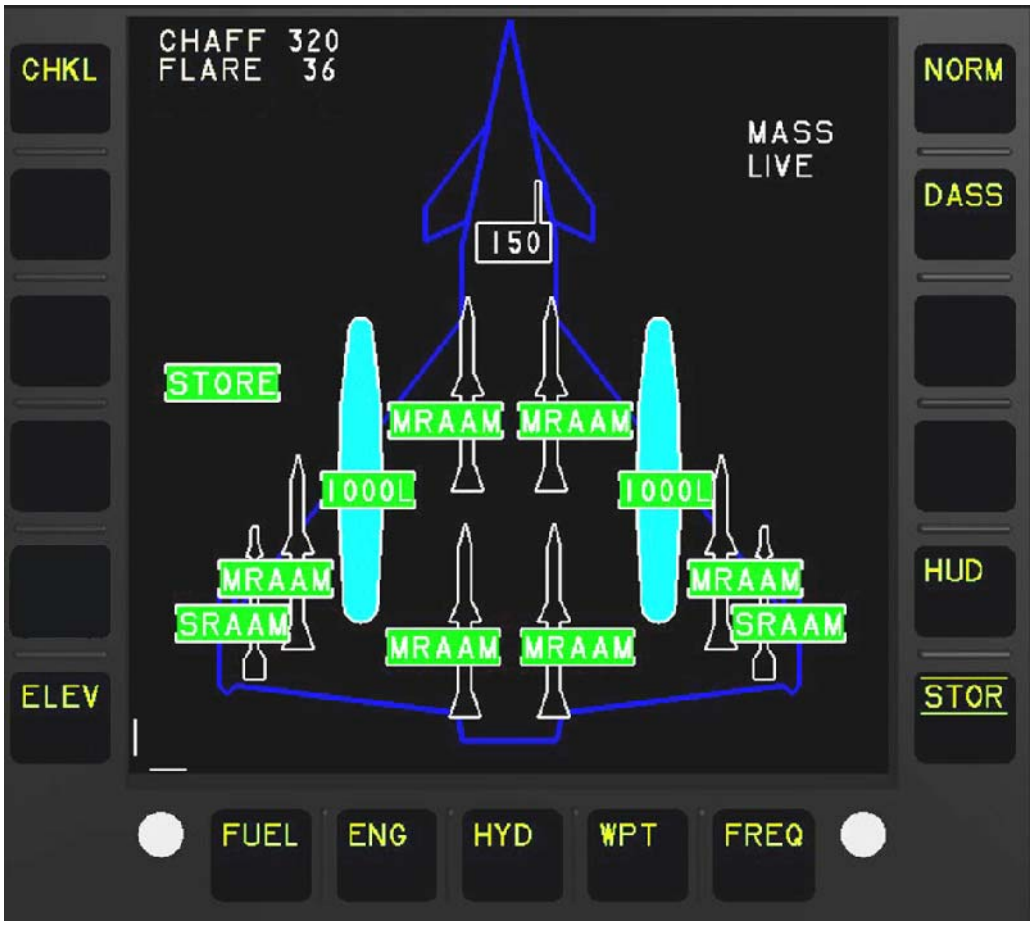


Figure 1.323 - Stores Format - Store Type

Armament Carriage and Installation System (ACIS)

(1B-B-94-30-00-00A-043A-A Issue 003)

general

The Armament Carriage and Installations System (ACIS) consists of specific items which are essential to the carriage of the stores in various weapon configurations.

The ACIS carries the stores in safe conditions and ensures safe separation and effective release/ jettison when commanded by the pilot.

The aircraft can carry external stores on its 13 suspension stations.

Weapon Station

The 13 weapon stations are located under the fuselage and under the wings (see Figure 1.324 Weapon Station and Pylon Configuration).

They are as follows:

– Four underfuselage stations dedicated to the Medium Range Air to Air Missiles (4 AMRAAM) and configured to a low drag missile installations (stations No. 2 and 3) on ejector launchers.
– One center underfuselage station where either pylon equipped with one Advanced Heavy Duty Ejector Release Unit (AHDERU; station No. 1) or the 1000 l Supersonic Fuel Tank (SFT) equipped with the Tank Ejector Unit (TEU) can be fitted.
– Six underwing stations (station 4, 5, 6 left and right). Stations 4 carry the inboard wing pylons equipped with AHDERUs. Stations 5 carry either the centre wing pylons equipped with AHDERUs or the 1000 lt Supersonic Fuel Tanks (SFT) equipped with Tank Ejecting Unit (TEU). Stations 5 are the wet stations when fuel tanks (1000 lt) are fitted. Stations 6 carry the outboard wing pylons equipped with Advanced Light Duty Ejector Release Units (ALDERU). A Multi Function Rail Launcher (MFRL) or a Twin Missile Carrier (TMC) equipped with two MFRL can be installed on the outboard pylon.
– Two underwing Integrated Tip Stub Pylon Launchers (ITSPL, in station 7) are dedicated for carrying/firing of SRAAM missiles.

ACIS CONFIGURATION

The external stores configuration is the basic AIR-TO-AIR with or without external fuel tanks. In the baseline configuration four AMRAAM and two SRAAM.

SYSTEM CONFIGURATION DESCRIPTION

To allow loading and carriage of the external store configuration, the ACIS is composed by the following equipments:

– Two Integrated Tip Stub Pylon/Launcher (ITSPL)
– Four full standard MRAAM Eject Launcher (MEL)

Integrated Tip-Stub Pylon/Launcher

The two Integrated Tip-Stub Pylon/Launcher (ITSPL) are fitted under the left and right wing of the aircraft (station 7). Each ITSPL is permanently bolted to the wing and is equipped with the following components:

– Rail Beam
– Integrated Tip Station Unit (ITSU)
– Missile Cooling System (HiPPAG)
– Detent Mechanism Common Component and Snubbers plus Interlink

The ITSPL function is to ensure carriage/firing of the SRAAM missiles. The ITSPL are not jettisonable.

Rail Beam

The Rail Beam is attached to the ITSPL structure by means of a large amount of equally spaced countersunk screws via anchor nuts fixed to the Rail Beam side walls. Its function is to allow the loading, unloading, firing and carriage of SRAAM missiles.

Integrated Tip Station Unit (ITSU)

ITSU is capable to converting aircraft power and processing aircraft/missile signals essential to a range operational and test functions. It is not part of ACIS.

Missile Cooling System (HiPPAG)

The High Pressure Pure Air Generator (HiPPAG) is an off-the-shelf item which supplies pure air as a cooling gas to the SRAAM. The HiPPAG is installed on a mounting tray to be compatible with both the MFRL and ITSPL installations.

The HiPPAG consists of three main components:

– Electronic Control Unit
– Motor/Compressor
– Filters

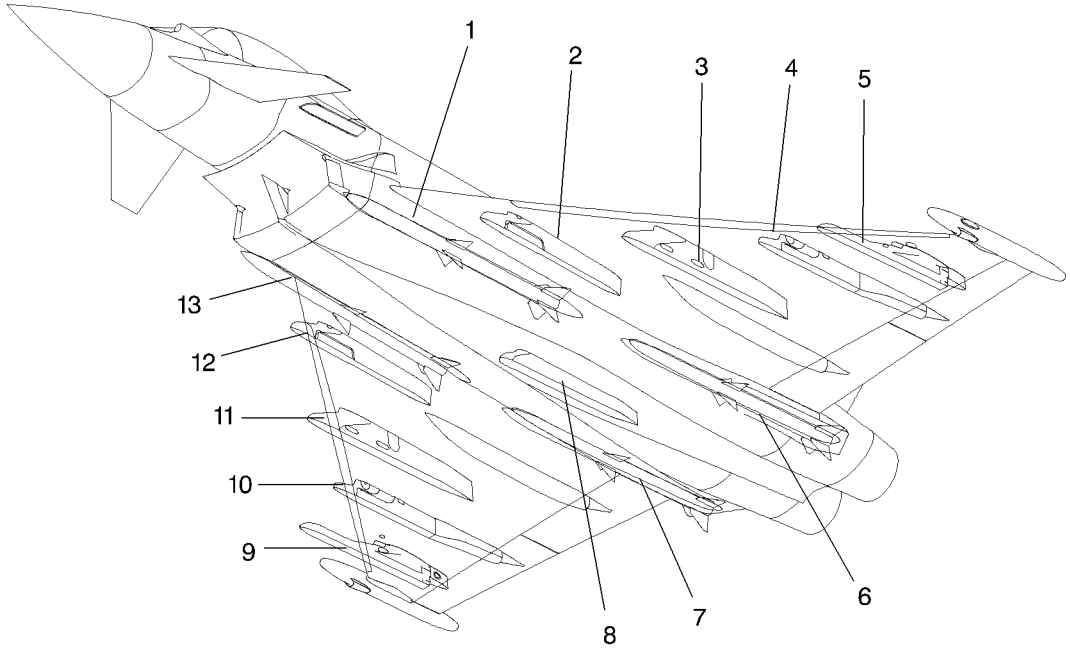
HiPPAG has also a control valve to shut off or open the gas supply to the missile.

MFRL Detent Mechanism Common Component and Snubbers plus Interlink

The Detent Mechanism Common Components and Snubbers are mounted on the rail beam by means of countersunk screws.
The function of the Detent Mechanism is to prevent fore and aft longitudinal movements of AMRAAM/ SRAAM missile during carriage by restrain the missile forward hanger, to allow engagement/ disengagement of the detent latches for missile loading/unloading and to permit the missile firing.
The main function of the snubbers is to eliminate all roll about the x-axis of the AMRAAM/SRAAM missiles throughout the flight envelope.

MRAAM Eject Launchers (MEL)

The MRAAM Eject Launcher is a twin ram launcher designed to allow correct loading/unloading, safe carriage, firing and jettison of the MRAAM throughout the full foreseen envelope. The MELs will be installed to carry four AMRAAM.
There are four MRAAM eject launchers fitted under the left and right center fuselage (station 3) and under the left and right rear fuselage (station 2).
The aft left hand launcher is identical to the fwd right hand launcher and conversely the aft right launcher is identical to the fwd left hand launcher.
Each MEL is bolted to the relevant two attachment points into the fuselage and is permanently attached to the aircraft. At all station the fuselage apertures are closed by a launcher mounted plate (baseplate).



1 FWD LH MRAAM EJECT LAUNCHERS (MEL) STATION 3
2 LH INBOARD WING PYLON (STATION 4)
3 LH CENTRE WING PYLON (STATION 5)
4 LH OUTBOARD WING PYLON (STATION 6)
5 LH ITSPL (STATION 7)
6 REAR LH MRAAM EJECT LAUNCHERS (MEL) STATION 2
7 REAR RH MRAAM EJECT LAUNCHERS (MEL) STATION 2
8 CENTRE UNDER FUSELAGE PYLON (STATION 1)
9 RH ITSPL (STATION 7)
10 RH OUTBOARD WING PYLON (STAITON 6)
11 RH CENTRE WING PYLON (STATION 5)
12 RH INBOARD WING PYLON (STATION 4)
13 FWD RH MRAAM EJECT LAUNCHERS (MEL) STATION 3

Figure 1.324 - Weapon Station and Pylon Configuration

MISCELLANEOUS

Cockpit Access Ladder

(1B-B-53-18-00-00A-043A-A Issue 002)

Introduction

The cockpit access ladder provides a means of cockpit ingress/egress in the event that a flight line cockpit ladder is not available, or the aircraft is deployed away from its home base. The ladder is a three piece telescopic assembly which pivots around a pintle. The ladder is housed in the ladder bay which is located on the left side of the front fuselage in front of the air intake for the left engine.

The ladder can be released from within the cockpit by using a guarded push button selector/indicator (Panel marked LADDER) or externally by using an unguarded square-headed toggle switch located under the left wing apex panel. Both methods require that the aircraft has Weight-On-Wheels with both throttle levers set in the HP SHUT position.

The hydraulic pressure for the ladder system is supplied from the in-flight refueling probe hydraulic system. The ladder hydraulic system has its own accumulator charged with Helium gas which maintains a constant pressure in the system. The accumulator allows a minimum of three ladder extensions before recharging is required.

The ladder assembly has been designed so that it can be removed from the aircraft quickly without tools if either the uplock or downlock assemblies fail and prevent its stowage. A pip pin which is used to retain the pintle is also used to withdraw the pintle and allow removal of the ladder from the aircraft.

Cockpit Egress

When the push button selector/indicator located below the right MHDD is pressed the red EXD legend is illuminated and the cockpit access ladder automatically deploys. The pilot is informed when the ladder is fully down and positively engaged in the downlock by red status bars illuminating above and below the legend.

WARNING

ENSURE GROUND CREW ARE AWAY FROM THE LADDER DEPLOYMENT AREA BEFORE PRESSING EXD.

CAUTION

THE LADDER SHOULD ONLY BE DEPLOYED 45 SECONDS AFTER SELECTING BOTH ENGINES TO HP SHUT.

CAUTION

THERE IS A BLACK STRIPE ON THE VERTICAL OUTER FACE OF EACH STEP OF THE LADDER ASSEMBLY. WHEN THE LADDER IS FULLY EXTENDED THE BLACK STRIPES MUST BE ALIGNED WHEN VIEWED FROM THE COCKPIT. THE PILOT MUST MAKE SURE THAT THIS CONDITION EXISTS BEFORE COCKPIT EGRESS.

Egress from the cockpit is shown in Figure 1.325 .

Ladder Stowage

The ladder must be correctly stowed before flight or when towing an aircraft. A diagram showing the stowage procedure is attached to the inside of the hinged ladder door assembly, refer to Figure 1.326 .

NOTE

With unfamiliar groundcrew in attendance, (e.g. when the aircraft is on detatchment) check that the push button selector/indicator marked LADDER, is unlit when the Battery Master Switch is set to BATT. This will indicate that the ladder has been stowed correctly by the groundcrew,

The telescopic section of the ladder is manually retracted to its minimum length and the ladder downlock mechanism release lever is depressed. The ladder is then swung forward and up until it is located and locked in the ladder uplock mechanism. The ladder door damper is then pushed inward to allow the closure of the ladder door assembly. The door should be closed using both hands and held closed until the locking mechanism shootbolts are heard to activate.

Cockpit Ingress

The ladder is released by use of the unguarded toggle switch in the left wing apex panel, refer to Figure 1.327 . Ingress to the cockpit is shown in Figure 1.328 .

Front Fuselage Unlock LED Indicator

The unlock indicator, refer to Figure 1.327 , is located in the panel adjacent to and aft of the ladder door. When the ladder door is opened from the cockpit the legend UNLK will illuminate (amber) while the Battery Master Switch remains set to BATT.

When the ladder door is held in the closed position, the door will contact two microswitches that will cause the shootbolt locking mechanism to activate. When the shootbolt mechanism is fully extended and the two shootbolts have contacted their microswitches, the UNLK legend will be extinguished. This will indicate that the ladder door has been fully closed and has been correctly locked by the shootbolts.

Controls and Indicators

The following indications will be displayed in the cockpit prior to engine start, refer to Figure 1.329 .

– LADDER push button selector/indicator

  - EXD is illuminated (red) with status bars illuminated (red) - ladder locked in down position
  - EXD is illuminated (red) - ladder and ladder and ladder door assembly unlocked
  - Unlit - ladder stowed and ladder door closed and correctly locked.

– MHDD/ACUE

  - Red ladder caption - indicates that the ladder door is open
  - Green ladder caption - indicates that the ladder door is closed.

NOTE

The DWP LADDER caption, plus attention getters, are suppressed until the throttle levers are moved from the HP SHUT position, whereupon the voice warning ““LADDER NOT STOWED„ is given.

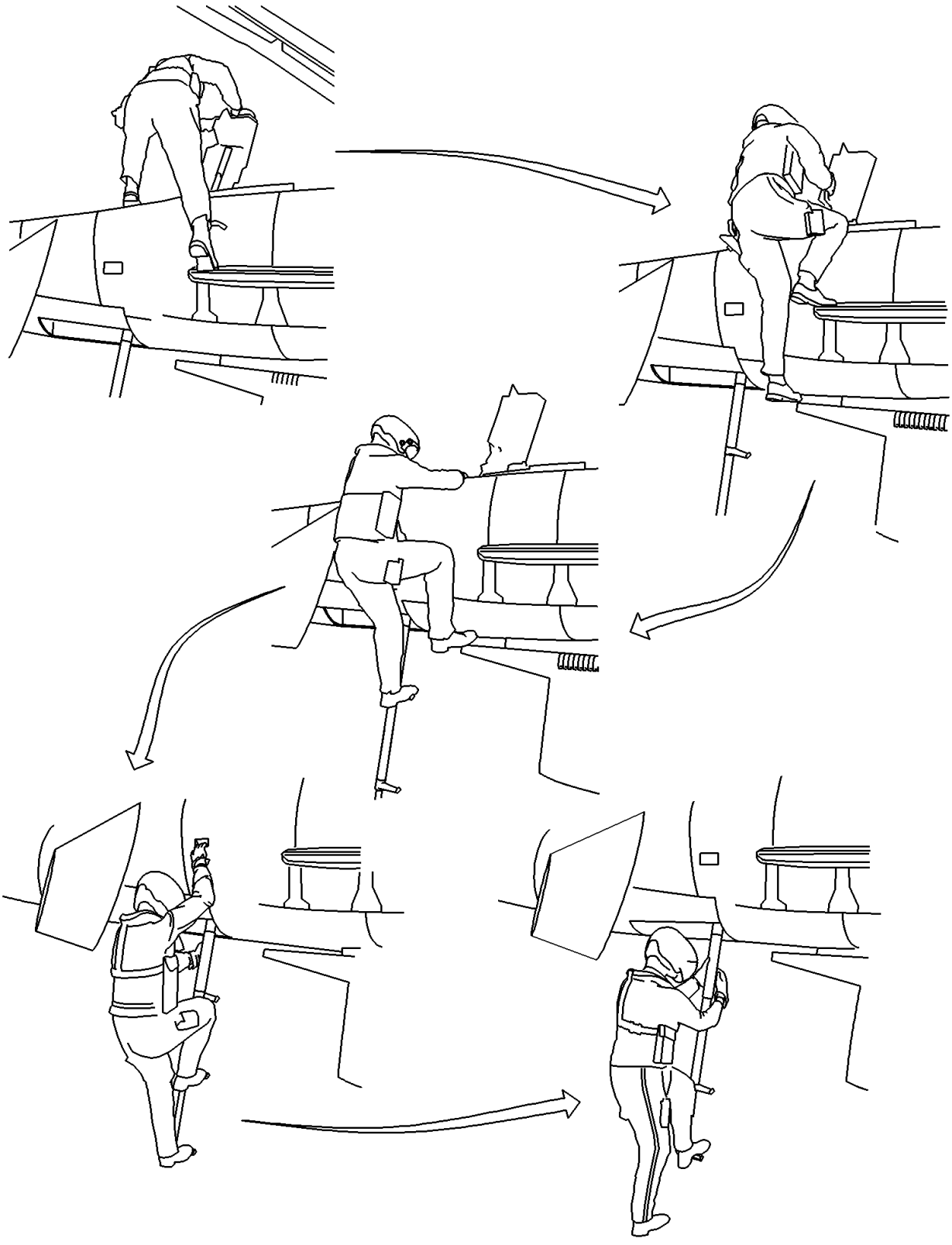


Figure 1.325 - Cockpit Egress

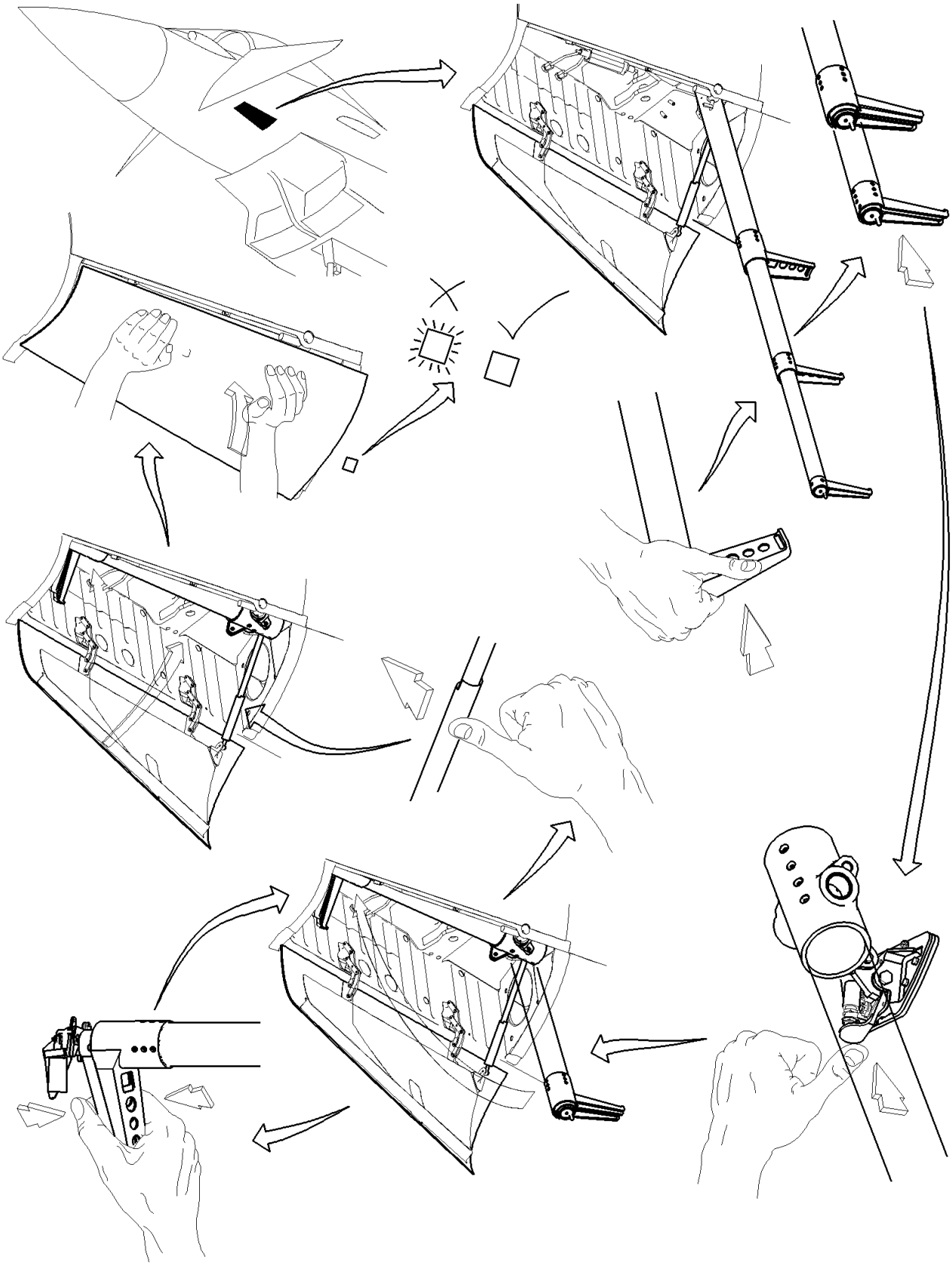
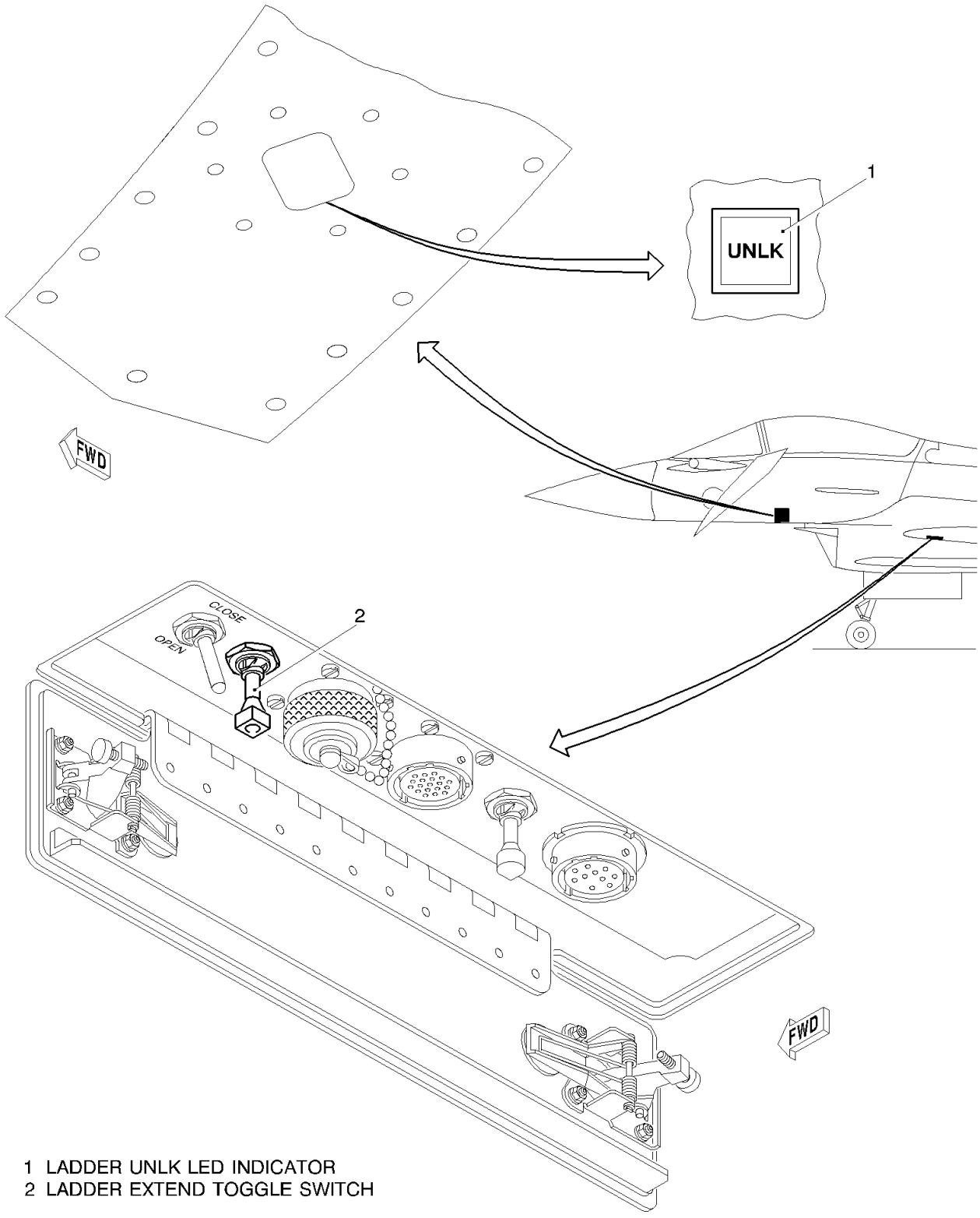


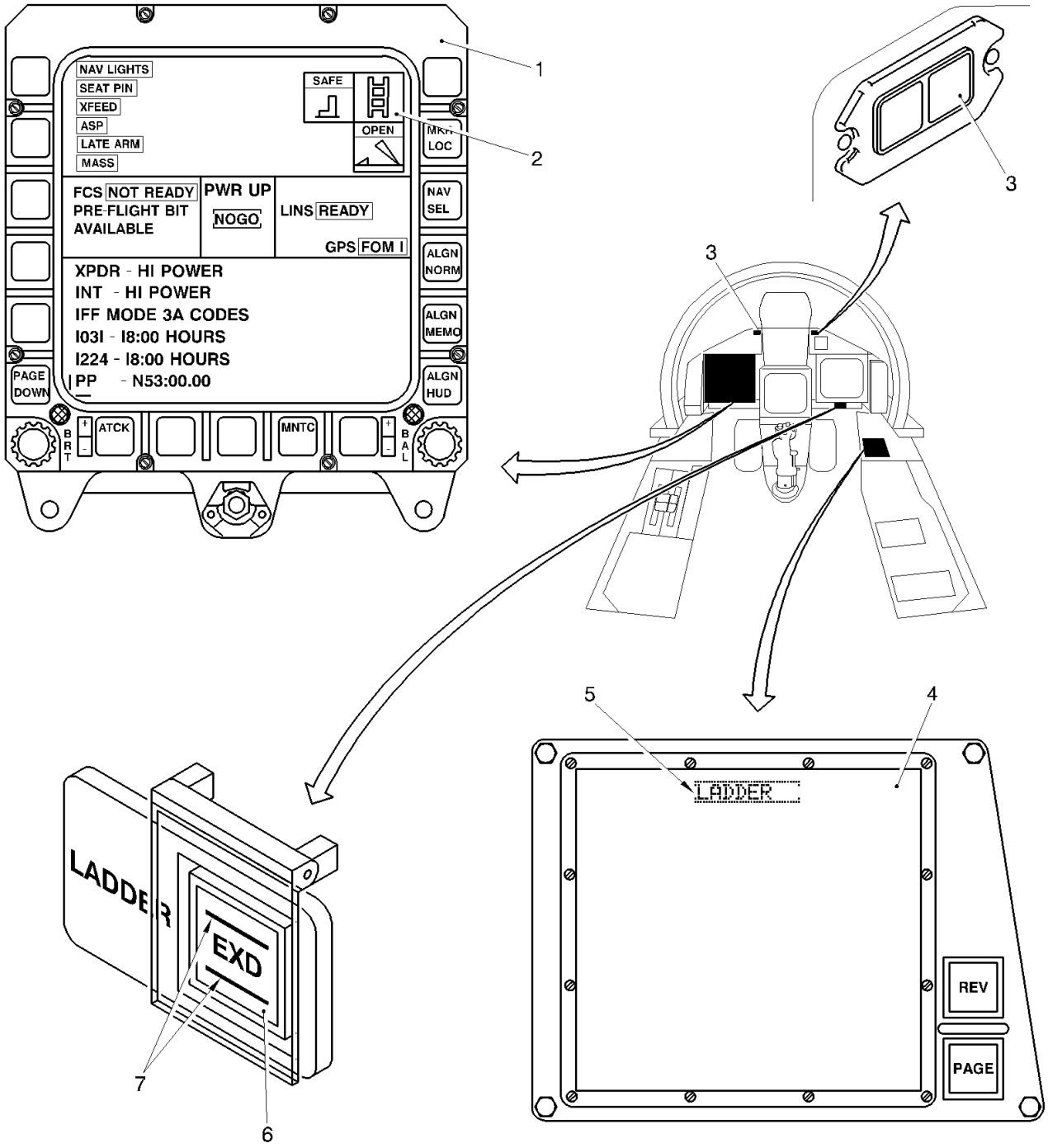
Figure 1.326 - Ladder Stowage Instructions



1 LADDER UNLK LED INDICATOR
2 LADDER EXTEND TOGGLE SWITCH

Figure 1.327 - Left Wing Apex Panel, Toggle Switch and LED Indicator

Figure 1.328 - Cockpit Ingress



1 MHDD
2 LADDER SYMBOL
3 ATTENTION GETTER
4 DEDICATED WARNING PANEL
5 LADDER CAPTION
6 LADDER EXTEND PUSHBUTTON SELECTOR/INDICATOR
7 STATUS BARS

Figure 1.329 - Ladder Controls and Indicators

Servicing Diagram

(1B-B-12-40-00-00A-043A-A Issue 003)

Servicing

SPECIFICATION SERVICING	NATO	US	SP	UK	GE	IT
FUEL	F34	MIL-T-83133 (JP8)	INTA 151316	DEF STAN 91-87/1 (DERD 2453)	TI 9130-0012	AER.M.C 141
	F35	ASTM D1655-92 (JET A-1)	INTA 151317	DEF STAN 91-91/2 (DERD 2494)		AER.M.C. 141
HYDRAULIC FLUID	H515	MIL-H-5606	INTA 157111	DEF STAN 91-48/2	VTL 9150-020	AER.M.0.261
OIL (ENGINE, GEARBOX and APU)	0156	MIL-L-23699		DEF STAN 91-101 (DERD 2499)		
AUXILIARY OXYGEN (GASEOUS)		MIL-O-27210				
FIRE EXTINGUISHING AGENT	BROMO-TRIFLUORO-METHANE (BTM) (HALON 1301)					
EXTERNAL ELECTRICAL POWER	115/200 V ac 3 phase 400 Hz 28 V dc					

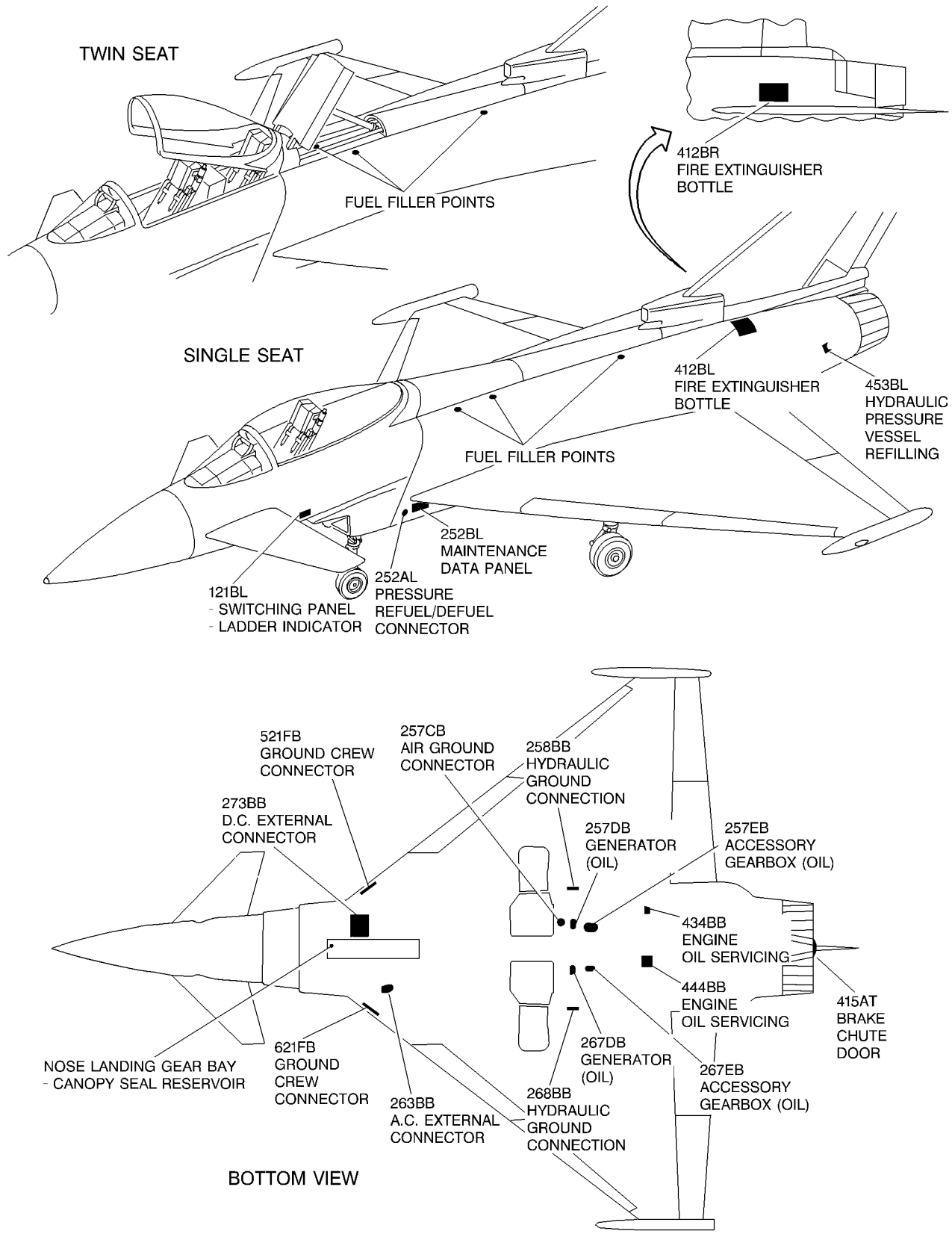


Figure 1.330 - Servicing Diagram

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SECTION 2 - NORMAL PROCEDURES

TABLE OF CONTENTS

Title	Page
ALERT	2-1
Alert Mode/Scramble	2-1
Daily Preflight	2-2
Cocking	2-2
PRE FLIGHT	2-2
Safe for Parking Checks	2-2
Initial Checks	2-3
External Checks	2-3
Ejection Seat Checks	2-5
Strapping in and Unstrapping	2-5
Internal Checks (Front/Rear Cockpit)	2-8
Rear Cockpit Safety Checks (Solo Flight)	2-8
STARTING ENGINE	2-8
Before Starting Engines	2-8
Starting Engines	2-15
After Engine Start	2-15
ALTERNATIVE ENGINE START	2-15
Crossbleed Engine Start	2-15
Start Failures / Start Cancel	2-15
Dry Crank	2-16
TAXI/LINE UP/TAKE OFF	2-18
Pre Taxi Checks	2-18
Taxiing	2-19
Before Take-Off Checks	2-20
Line Up	2-20
Taxi Back	2-20
Takeoff	2-21
CLIMB/CRUISE	2-21
Normal Climb	2-21
Minimum Time Climb	2-22
Cruise	2-22
AIR TO AIR REFUELING	2-22
In-flight Refueling	2-22
DESCENT/RECOVERY	2-23
Holding	2-23
Descent/Recovery	2-24
TACAN Approach	2-25
Radar/GCA Approach	2-25
Circling Approach	2-26
Go Around	2-26
Missed Approach	2-26
LANDING	2-26
Pre Landing	2-26
Normal Landing	2-27
Crosswind Landing	2-28
Landing on Slippery Runway	2-28
Touch and Go Landing	2-28
Braking Technique	2-29
AFTER LANDING	2-29
After Landing	2-29
Engine Shut Down	2-30
RECOVERY DATA	2-30
Recovery Data	2-30

ALERT

Alert Mode/Scramble

(1B-B-15-32-14-00A-131A-A Issue 003)

Introduction

Alert Mode is a method of setting the aircraft up for rapid start and takeoff, while on immediate standby with the Auxiliary Power Unit (APU) running, the engines off and no ground power applied. The following assumptions have been made in defining the procedures for this state of readiness.

Assumptions

It is assumed the aircraft is manned by the pilot and the ground crew are in attendance.

APU Alert Mode - Load Shedding

A fully automated load shedding system is used to limit the demand on the APU generator by powering down equipment that is not required during the Alert Mode. During the Alert Mode the following will be affected:

– Armament Control System
– All DASS except the Chaff and Flare Dispensers and DAC
– All rear cockpit MHDD
– Left and right boost pumps
– Windscreen heater control unit.

Procedures

After performing the usual internal checks the aircraft may be taken to the Alert Mode or Scramble.

Alert Mode

1. APU.....Start or ensure running
2. Strap in
3. PDS.....Insert into MDLR
4. Battery gangbar.....On
5. Radar .....SBY
6. ACUE format.....Confirm on-board ladder stowed
7. MASS.....STBY

Scramble

1. Engines .....Start
2. Canopy .....Close and lock
3. FCS RSET .....Press
4. Parking brake.....Release
5. MASS.....LIVE
6. Seat safety lever .....ARMED

Daily Preflight

(1B-B-15-32-18-00A-131A-A Issue 004)

Description

The daily preflight phase presumes that the aircraft has been completely preflighted (as per the following list). This procedure contains brief checks of certain items to ensure that the aircraft remains ready for flight. Check all blanks, covers, pins and plugs are removed. Check inlets and outlets are clear, and doors secured. Check all pylons and stores. Remove all weapon blanks, covers and plugs with the exception of the SRAAM seeker head covers.

Procedure

1. All blanks, covers, pins and plugs.....Removed
2. All inlets and outlets ...Clear
3. All access doors (including external canopy jettison handle) .....Secure and closed
4. Nose wheel tire .....Condition, inflation
5. Radome.....Secure (2 latches each side)
6. ADT .....Condition
7. All pylons and stores ..Check, remove all weapon blanks, covers and plugs with the exception of SRAAM seeker head covers
8. RH main wheel tire.....Condition, inflation
9. Arrester hook.....Secure, pin removed
10. Brake parachute.....Marker flag visible, pin removed
11. LH main wheel tire .....Condition, inflation

Cocking

(1B-B-15-32-16-00A-131A-A Issue 006)

Introduction

The cocking procedures detail the actions required to prepare a fully preflighted aircraft to be safe and ready for scramble.
To cock the aircraft on the flight line refer to Cocking pag. 2-2.

Procedure

1. Internal checks ..... Carry out, Internal Checks (Front/Rear Cockpit) pag. 2-8, or If a solo flight is required, Rear Cockpit Safety Checks (Solo Flight) pag. 2-8
2. Engines ..... Start, refer to Starting Engines pag. 2-15

After engine start (up to the point of taxying) confirm:

3. PDS ..... Check data downloaded. Correct as required
4. Stores configuration and selective jettison ..... As required
5. SRAAM / AMRAAM BIT checks..... As required
6. LINS ..... Do not select NAV
7. Engines ..... Shut down

PRE FLIGHT

Safe for Parking Checks

(1B-B-15-32-01-00A-121A-A Issue 001)

Safe for Parking

The aircraft is safe for parking when:

1. Seat safety lever..... SAFE
2. MASS ..... SAFE
3. PARK BRK ..... ON

Safe for Servicing

The aircraft is safe for servicing when:

1. Seat safety lever..... SAFE, pin inserted
2. Canopy jettison handle pin..... Inserted
3. MASS ..... SAFE

4. All other switches..... Guarded, OFF or SAFE

Initial Checks

(1B-B-15-32-02-00A-121A-A Issue 001)

The appropiate maintenance form must be checked for aircraft status, armament loading and servicing. The appropiate mass and balance form must be also checked.

Before exterior inspection check that:

1. PARK BRK..... ON
2. BATT ..... OFF
3. MASS ..... SAFE

External Checks

(1B-B-15-32-03-00A-121A-A Issue 003)

The exterior inspection begins at the boarding ladder and continues around the aircraft in a clockwise direction (see Figure 2.1). Check inlets and outlets are clear, doors secured, covers off and pins removed. Be alert for loose fasteners, cracks, dents, leaks and other general discrepancies. Systematically check all pylons, launchers and stores.
Specifically accomplish the following:

Left center fuselage

1. Engine air intake cowls..... Clear
2. External canopy jettison handle ..... Secured and covered

Nose section

3. Foreplanes..... Condition
4. Radome ..... Secure (2 latches, both sides)
5. ADT ..... Condition
6. Nose tire ..... Condition, inflation

Right wing

7. Slats..... Condition
8. Flaperons..... Condition
9. Main tire..... Condition, inflation

Rear fuselage/Fin

10. Arrester hook ..... Secured, pin removed
11. Brake chute and door ..... Marker flag visible, door closed, pin removed
12. Fin and rudder ..... Condition

Left wing

13. Flaperons..... Condition
14. Slats..... Condition
15. Main tire ..... Condition, inflation

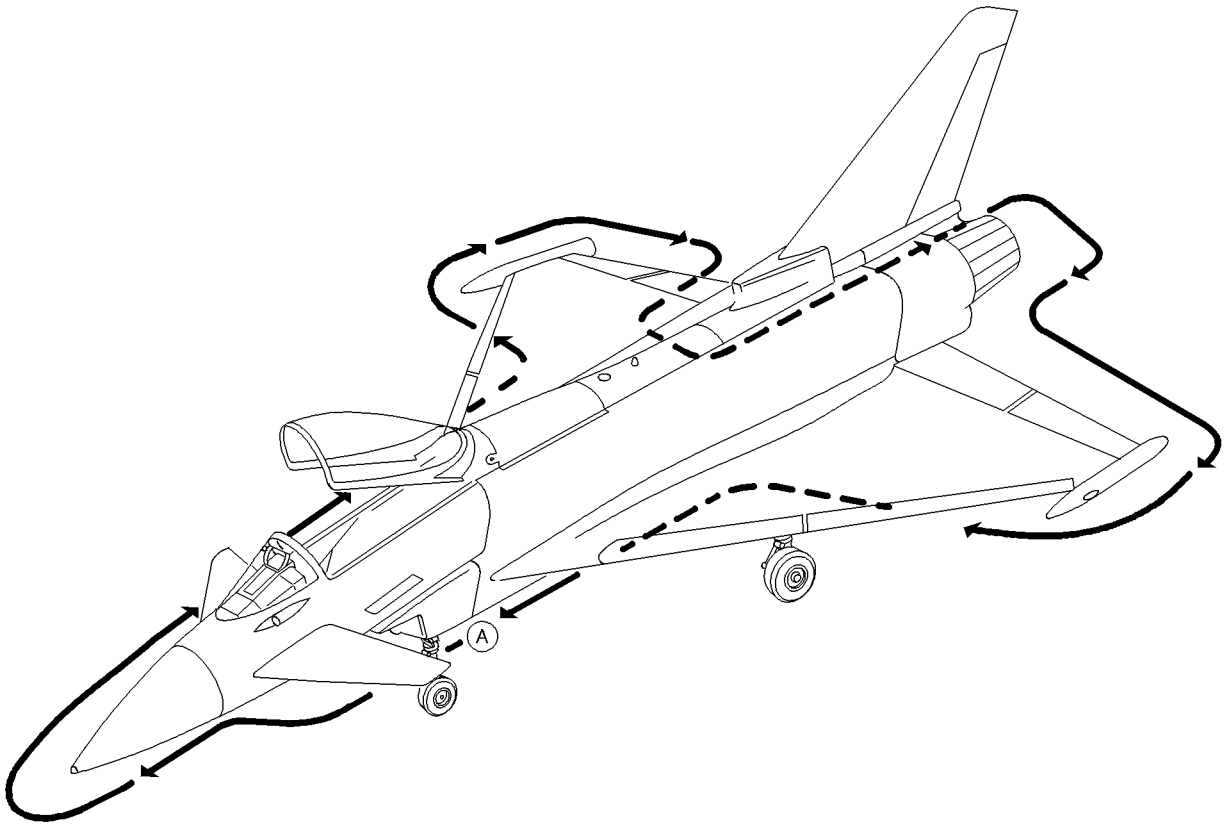


Figure 2.1 - Exterior Inspection

Ejection Seat Checks

(1B-B-15-32-04-00A-121A-A Issue 004)

Description

Before strapping in the seat installation must be checked, first for safety, then that the restraint lines and straps are correctly positioned and the appropriate levers and selectors are set correctly.

Procedure

1. Seat safety lever ..... SAFE, check pin(s) stowage
2. PSP lowering selector ..... As required
3. ADU/ALIU static lines ..... Secure
4. Anti-g valve ..... On (fwd)
5. Oxygen regulator selector ..... MAIN
6. PSP/strap connectors ..... Straps connected to harness, connector assembly in clip
7. Auxiliary oxygen handle ..... Reset (down)

Strapping in and Unstrapping

(1B-B-15-32-05-00A-121A-A Issue 004)

Before Strapping in

WARNING

BEFORE ENTERING THE COCKPIT ENSURE THAT THE EJECTION SEAT SAFETY LEVER IS IN THE SAFE POSITION AND THAT THE SEAT AND CANOPY SAFETY PIN ARE STOWED.

The procedure in Ejection Seat Checks pag. 2-5 must be performed before proceeding.

Strapping In

1. Enter the cockpit taking care not to stand on the seat firing handle. Sit well back in the seat.
2. Adjust the height of the seat pan to the normal in-flight eye-line position.
3. Adjust the rudder pedals as required.
4. Remove the Aircrew Services Package (ASP) seat portion cover and pass to the ground crew. Insert the ASP man portion pressing the rear of the handle firmly down until it locks in place.
5. Insert the Personal Survival Pack (PSP) lowering line arrowhead connector into the Quick Release Fitting (QRF).
6. If the Liquid Conditioning Garment (LCG) is worn, remove the Liquid Suit Connector Assembly (LSCA) seat portion cover and pass to the ground crew. Locate the LCSA man portion to engage with the seat portion and push fully down to lock, refer to Figure 2.2 for LSCA Hose Routing.
7. Bring the harness QRF and the crotch straps up between the legs. Lay the crotch straps against the inner thigh making sure they are not crossed or twisted.
8. Bring the lap straps up and lay over the thighs, routing the crotch strap loop through the lap strap metal ‘D’ rings.
9. In turn, bring down the shoulder straps, passing the shoulder strap lugs through the loop in the crotch straps from rear to front. Turn the lugs inwards, towards the QRF. Rotate the QRF faceplate and engage the lugs. **Do not tighten the shoulder straps or thigh straps at this point.**
10. Route the arm restraint lines through the ‘Velcro’ beckets at the lower end of each shoulder strap. Rotate the QRF faceplate to engage the lugs into the QRF.
11. Fully tighten the lap straps making sure the QRF remains central. Remove any slack from under the lap straps by pulling on the upper strap before final tightening. Stow the excess strap in the elastic beckets. If required, roll any excess strap inboard before stowing.
12. Sit slightly forward and tighten the shoulder straps, making sure that the straps are tensioned firmly around the body. Lift the shoulders in turn to pull any slack out from behind the occupant. Sit back in the seat and make sure the shoulder straps are comfortable and not over tensioned.
13. Sit fully forward and make sure there is full forward movement.
14. Connect the mask oxygen hose and the comms connector.

Unstrapping

1. Holding the ASP man portion manual release handle, press the handle locking lever and rotate the handle upwards.
2. Move the Safe/Armed/Egress handle to the ‘EGRESS’ position. This action will release the following:

– LCSA - Man portion
– PSP - Lowering line arrowhead connector

3. To release the QRF, grasp the faceplate, press the release button and rotate the faceplate as far as possible until it locks fully open. The shoulder straps and the arm restraint lines lugs will release simultaneously.
4. Free the shoulder straps, thigh straps and crotch straps and lay them clear of the QRF.

NOTE

Care must be taken to avoid damage to cockpit mounted equipment during egress by the man portion attached to the aircrew.

5. Vacate the cockpit.

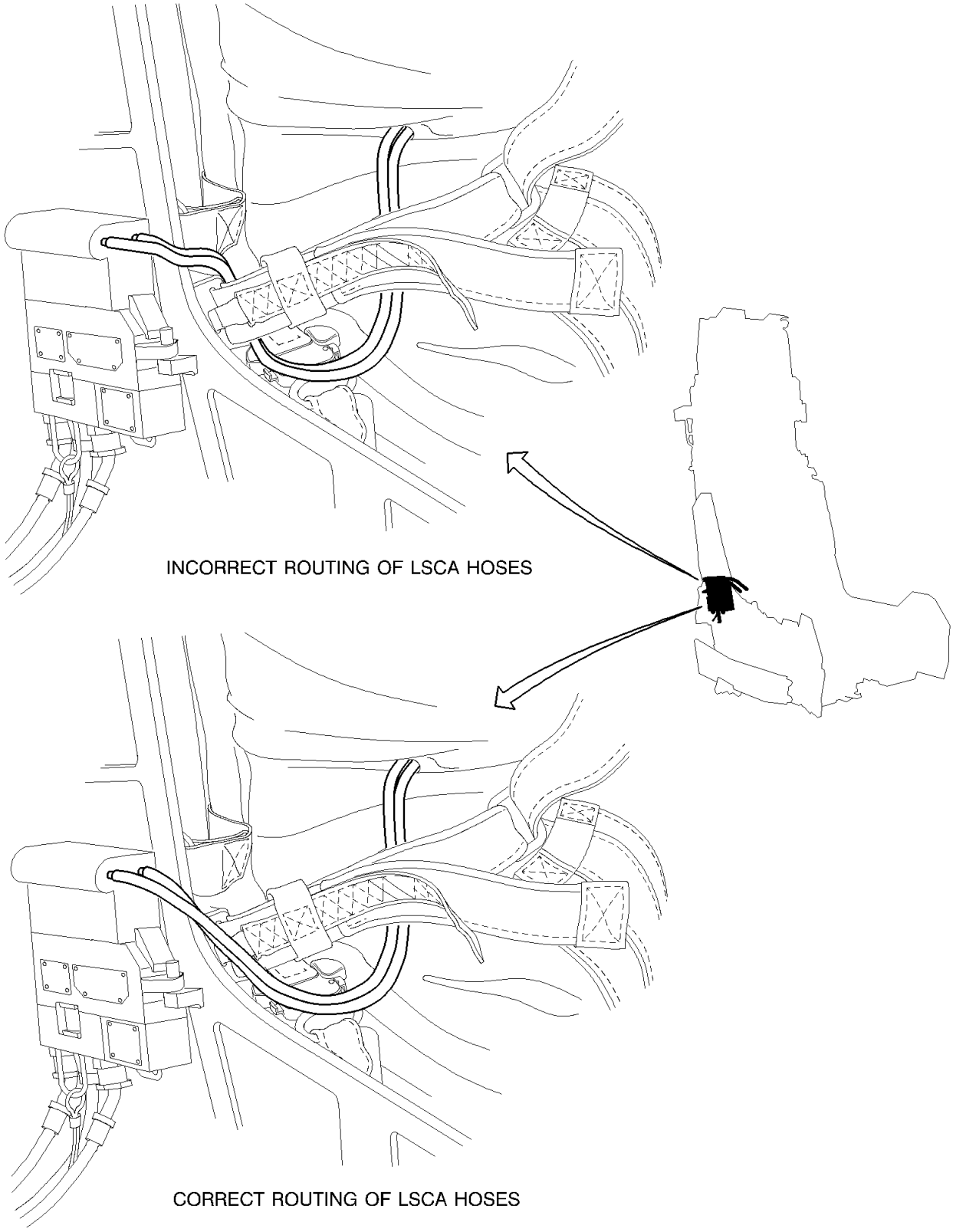


Figure 2.2 - LSCA Hose Routing

Internal Checks (Front/Rear Cockpit)

(1B-B-15-32-07-00B-121A-A Issue 006)

Description

After strapping in, switches and levers must be selected to, or ensured already in, the correct position before electrical power on and subsequent engine start.

Procedure

Prior to electrical power on:

1. PDS.....Insert
2. PIC .....As required
3. PARK BRK.....ON
4. Expendable Release Manual Control.....OFF
5. Throttles .....HP SHUT
6. Landing gear lever .....DOWN
7. MHDD and HUD.....ON
8. Late arm .....Safe position
9. FUEL PROBE (switch).....To match probe position until hydraulics available
10. Battery gangbar.....OFF
11. MASS .....SAFE
12. Systems gangbar .....Forward
13. All other switches .....Guarded, AUTO or forward

Rear Cockpit Safety Checks (Solo Flight)

(1B-B-15-32-08-00B-121A-A Issue 006)

Description

When the aircraft is to be used for solo flight further switch and lever selections must be set or checked in the rear cockpit.

NOTE

With the Command Mode Selector (CMS) set to SOLO all lighting in the rear cockpit goes out.

Procedure

Prior to entering the front cockpit the following procedure must be performed in the rear cockpit:

1. LP COCKS ..... OPEN, guards down
2. All other switches ..... Guarded, OFF or NORM
3. MHDD and HUD..... OFF
4. Course heading marker selector ..... Detent
5. Seat safety lever..... SAFE
6. CMD EJECT..... SOLO (locked)

STARTING ENGINE

Before Starting Engines

(1B-B-15-32-09-00A-121A-A Issue 005)

NOTE

Before starting engines, assure chocks are in place, fire guards are posted and danger areas are kept clear.

NOTE

When the radar is ground operated the area shown in Figure 2.3 may be subject to radiation burn hazard.

NOTE

- For the extent of engine/APU intake and exhaust hazard areas refer to Figure 2.4 and Figure 2.5. For the estimated noise level areas refer to Figure 2.7.
- Engine velocity and temperature profile are showed in Figure 2.6

Establish intercom with the ground crew, confirm whether the APU or the pneumatic ground cart is to be used and ensure that the ground crew is ready for engine start. After canopy has been closed, check that the CNPY warning is not lit and access ladder has been stowed.
Check that the following formats are presented on the MHDD's:

– L MHDD: Autocue format (ACUE)
– C MHDD: PA format (PA)
– R MHDD: Engine format (ENG)

NOTE

When the MASS is set to STBY or LIVE, RMHDD switches to STOR format.

DECU Built-in Test (BIT)

The system built-in test (BIT) comprises a system initiated built-in test (IBIT) and system continuous built-in test (CBIT), to monitor engine control system functions and check out serviceability.

Initialization of the DECU takes place when the throttle is moved from HP SHUT to IDLE (i.e. DECU power-up).

IBIT is performed automatically after initialization of DECU and is completed within two seconds. Engine start is initiated when IBIT is completed.

If the IBIT detects defects which would cause a "Loss of Control" failure, engine start will be inhibited and L/R DECU failure warning indication followed by audio warning will be available to the pilot, via the FCS bus. After completion of DECU IBIT the following indications will be available:

MHDD/ENG format:

- L/R OIL P
- L/R NL: 0%
- L/R NH: 0%
- L/R AJ: 100% (± 2%)
- L/R INTK: –26°
- L/R L1/L2 SK: L1 or L2 boxed
- TBT value

NOTE

Minimum TBT gauge reading is 600°C. TBT indications up to 600°C are showed blank on MHDD.

DWP:

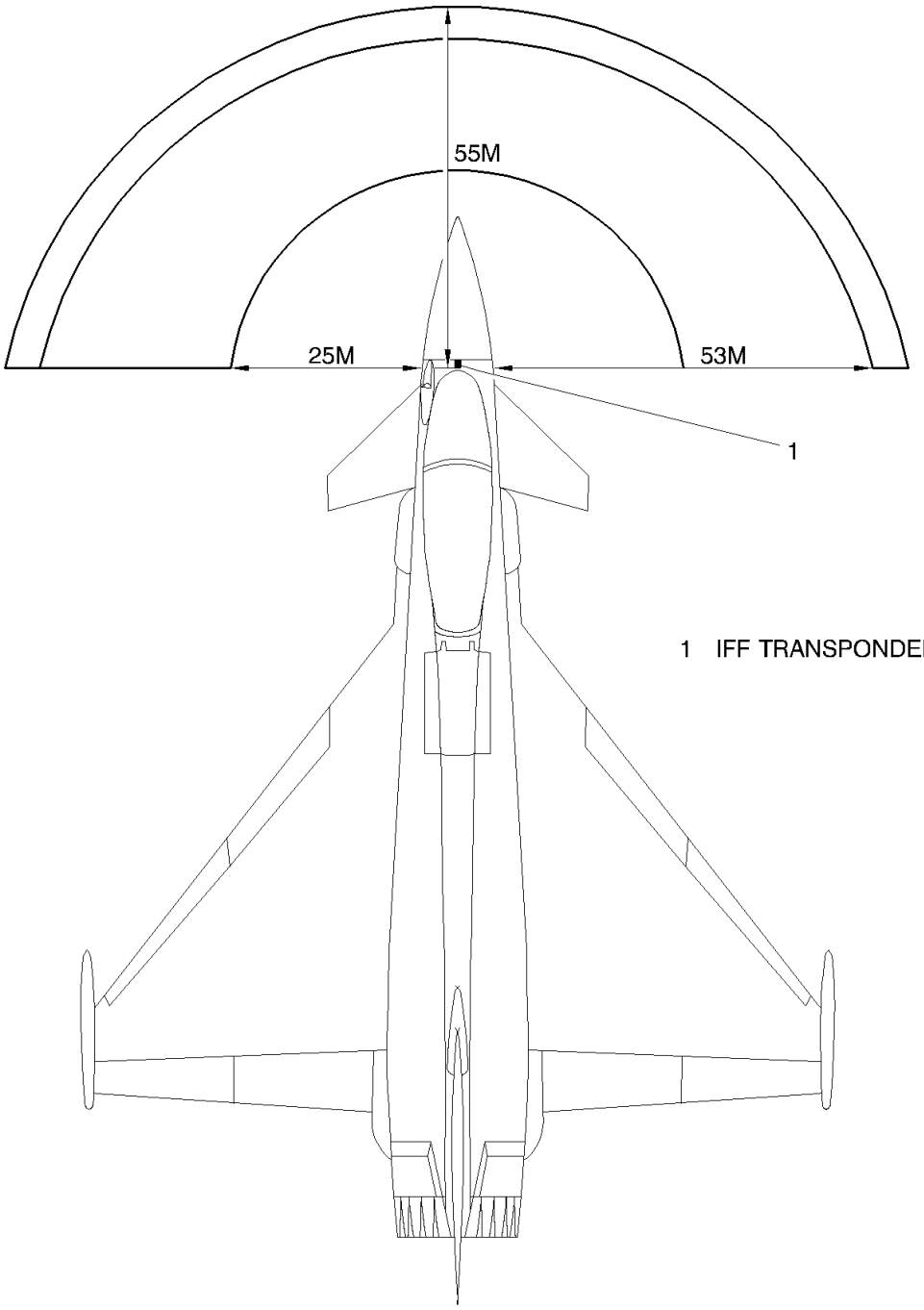
- L/R OIL P

The health of the control system is monitored by continuous BIT while the equipment is operating in its selected mode, without interfering with the operation of the system.

1. Battery gangbar ..... On
2. External lights ..... As required
3. APU ..... START
4. Cockpit lighting ..... As required
5. MASS ..... STBY
6. Landing gear indications..... Three green
7. MHDD/ACUE..... Check

A 53 METERS - PERSONNEL MUST NOT GO INTO THIS AREA WHEN THE RADAR OPERATES
B 55 METERS - ELECTRO-EXPLOSIVE DEVICES MUST NOT BE IN THIS AREA WHEN THE RADAR OPERATES
C 25 METERS - FUEL MUST NOT BE IN THIS AREA WHEN THE RADAR OPERATES

ALL OF THE AREAS ARE RADIAL HEMISPHERES MEASURED FROM THE REAR OF THE RADAR RADOME AND THE FORWARD IFF TRANSPONDER.



1 IFF TRANSPONDER FWD.

Figure 2.3 - Dangerous Areas Radar On Ground

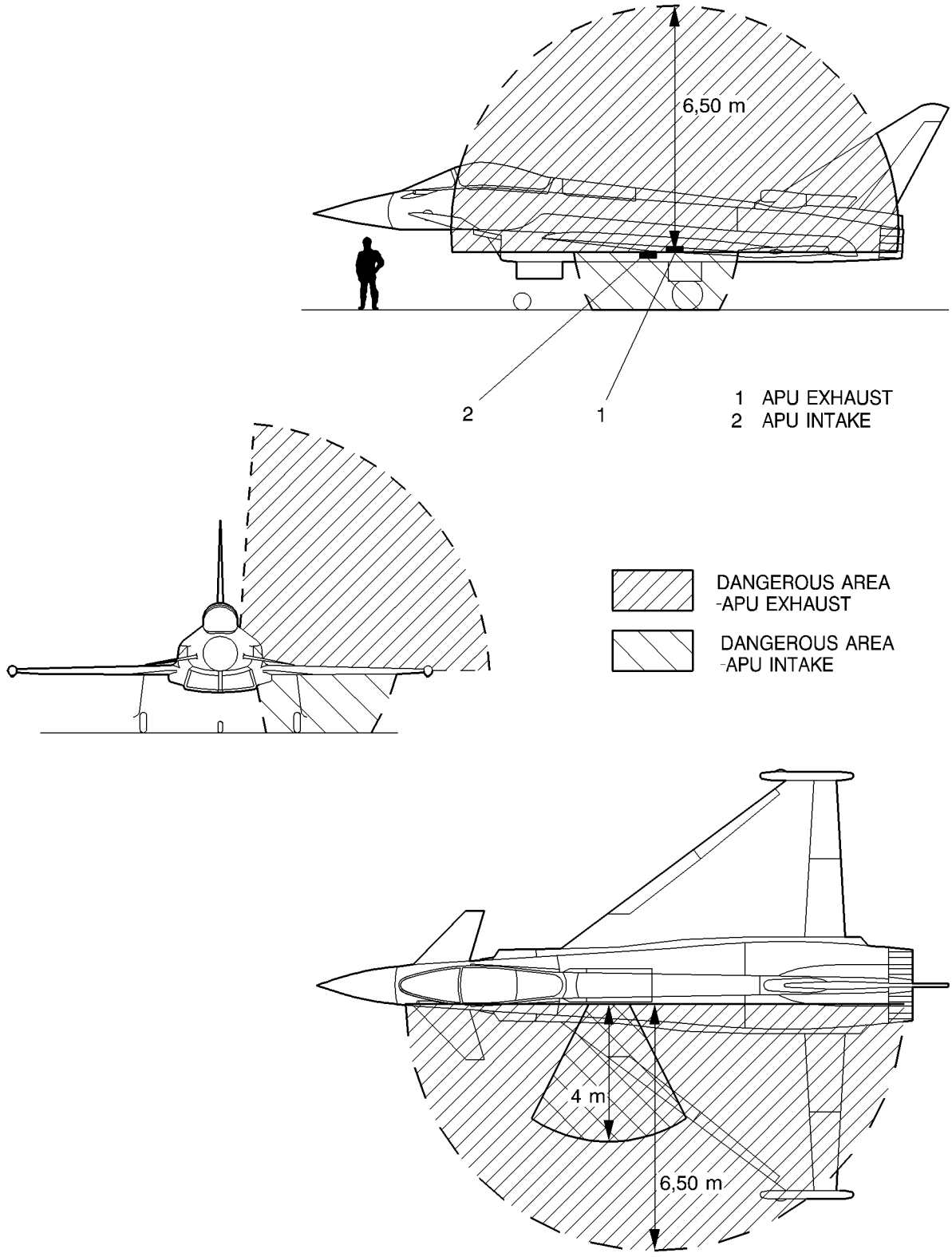


Figure 2.4 - Dangerous Areas During APU Operation.

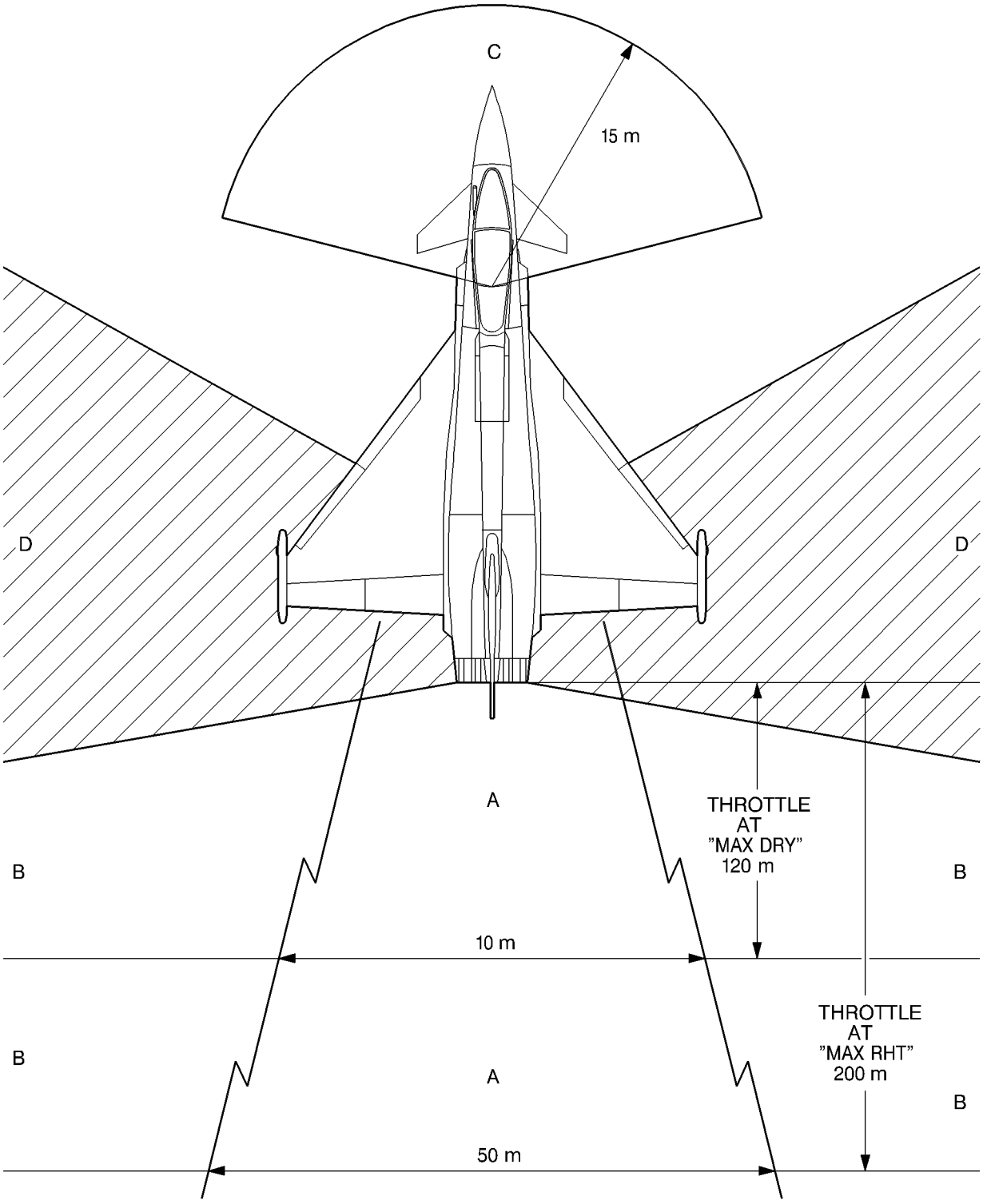


Figure 2.5 - Dangerous Areas During Engines Operation.

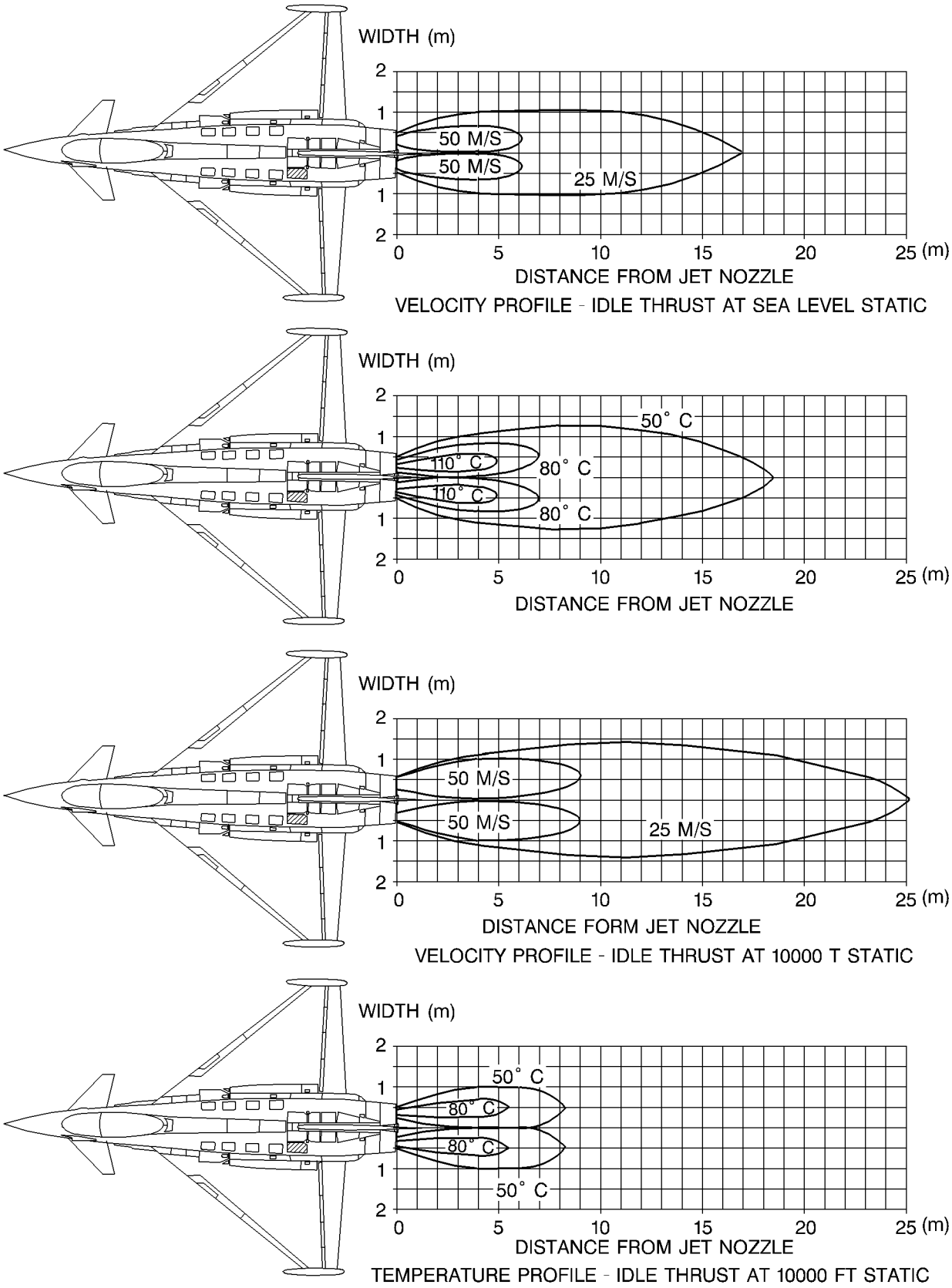


Figure 2.6 - Velocity and Temperature Profiles at Idle Thrust.

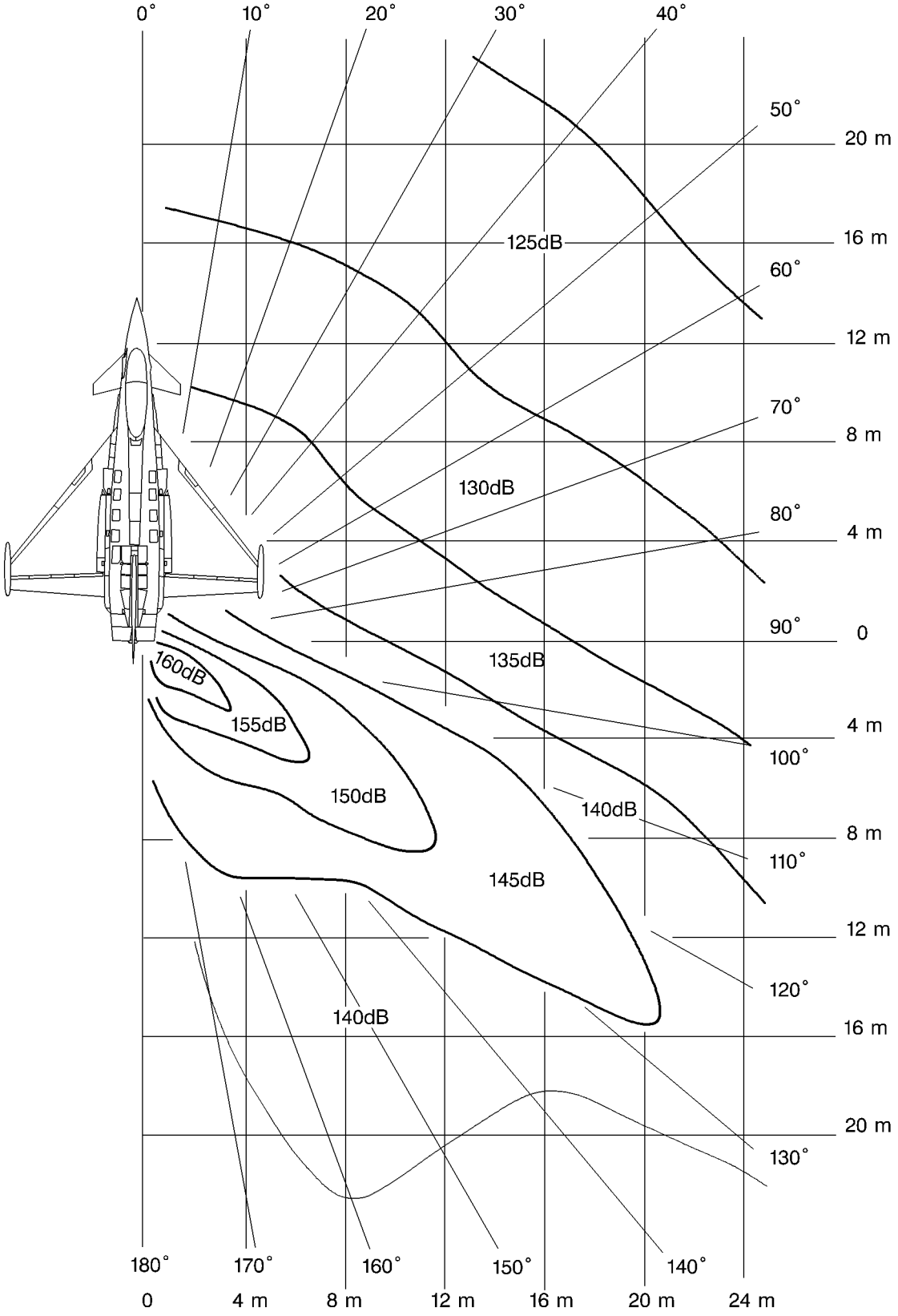


Figure 2.7 - Estimated Noise Levels - Right Engine at MAX RHT Power.

Starting Engines

(1B-B-15-32-10-00A-131A-A Issue 006)

Acquire ground crew clearance before starting engines.

To initiate ground starting move the throttle from SHUT to IDLE.

Typically, IDLE is reached in approximately 35 seconds at sea level.

1. L and/or R Throttle(s) ..... IDLE, check NH increasing

If alternative start-up required:

2. Refer to Crossbleed Engine Start pag. 2-15

After Engine Start

(1B-B-15-32-11-00A-131A-A Issue 006)

When both engines are running the APU is automatically shut-down.

Engine start at cold OAT may result in diminished engine response to throttle demand above IDLE. This problem usually cures itself during the time required for ground checks. L/R GEN captions are out when reaching 60% NH and the ATS/M caption is not displayed.

1. APU RUN..... Not lit
2. DWP ..... No red captions
3. MASS ..... STBY

ALTERNATIVE ENGINE START

Crossbleed Engine Start

(1B-B-15-35-01-00A-131A-A Issue 007)

The crossbleed engine start is done with the live engine only during parking or taxiing. For both conditions, switch off the APU, if operating.

NOTE

The APU is automatically shut down for ground speed greater than 10 KDAS (5 m/s).

Advance the live engine to 65% NL minimum and at stabilized RPM set the other throttle to IDLE. After the second engine is stabilized in IDLE, retard the first throttle to IDLE.

1. APU ..... STOP
2. Throttle live engine .... 65% NL minimum
3. Other throttle..... IDLE, check NH increasing
4. Continue with After Engine Start pag. 2-15

Start Failures / Start Cancel

(1B-B-15-35-02-00A-131A-A Issue 006)

General

The start is cancelled automatically by DECU if any of the following conditions is detected:

– the engine doesn't reach idle within 60 seconds from start initiation
– TBT exceeds 675°C for 5 seconds or 850°C instantaneously
– there is a DECU loss of control
– emergency spill valve (ESV) control is invoked

The pilot must abort the engine starting if any of the following conditions exist:

– An internal engine bay fire is detected
– OIL P caption is still displayed after the engine reaches idle speed

To cancel engine start, proceed as follows:

1. Throttle(s) ..... HP SHUT
2. LP COCK(s)..... SHUT

Jet Pipe Fire

CAUTION

THERE IS NO COCKPIT WARNING OF A JET PIPE FIRE, AND THE PILOT IS DEPENDENT ON ADVICE FROM THE GROUND CREW.

If there is a jet pipe fire, do not cancel the start unless a greater emergency exists.

During engine start, a flash fire, which is not harmful to the engine, may be ignored. This will be recognized by flames passing out of the rear of the exhaust system for a duration not exceeding five seconds. Although unlikely, flash fires can be caused by delayed ignition or a previous failed start.

CAUTION

A SUSTAINED FIRE (MORE THAN FIVE SECONDS), WHICH MAY BE HARMFUL TO THE ENGINE, MUST BE THREADED AS A FIRE IN THE JET PIPE.

CAUTION

IF A SUSTAINED FIRE IS OBSERVED BY THE GROUND CREW, IT MUST BE REPORTED IMMEDIATELY TO THE PILOT.

Usually, the fire extinguishes continuing the engine start. If the starting action doesn't extinguishes the fire, shut down the engine and carry out the dry crank procedure (refer to Dry Crank pag. 2-16). When the dry crank procedure is not possible or fails, apply the external fire suppression procedure.

NOTE

In the event of a Jet Pipe Fire during engine shut down, a dry crank should be carried out to dissipate heat and flames.

Dry Crank

(1B-B-15-35-03-00A-131A-A Issue 007)

A Dry Crank is carried out to drain fuel following a failed start or in the event of a jet pipe fire to dissipate heat and flames. A dry crank operation takes about one minute.

NOTE

Refer to Figure 2.8 to determine if a dry crank must be carried out prior to starting the engine.

1. LP COCK affected side.....SHUT
2. Relevant throttle.....IDLE, monitor NH increasing

When appr. 27% NH is reached:

3. Throttle affected engine .....HP SHUT

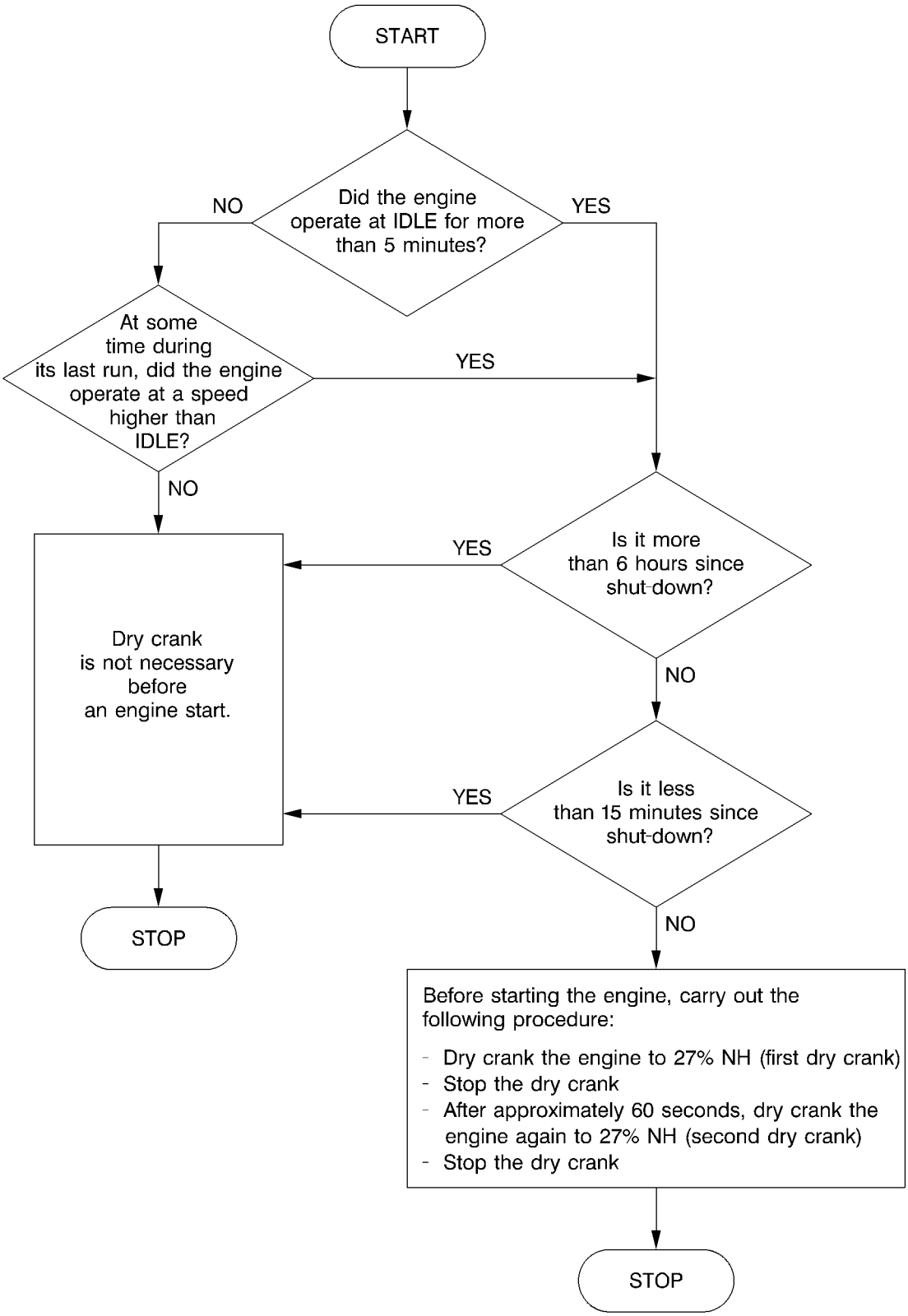

START
Did the engine operate at IDLE for more than 5 minutes?
NO
YES
At some time during its last run, did the engine operate at a speed higher than IDLE?
YES
NO
Is it more than 6 hours since shut-down?
YES
NO
Dry crank is not necessary before an engine start.
Is it less than 15 minutes since shut-down?
YES
NO
STOP
Before starting the engine, carry out the following procedure:
- Dry crank the engine to 27% NH (first dry crank)
- Stop the dry crank
- After approximately 60 seconds, dry crank the engine again to 27% NH (second dry crank)
- Stop the dry crank
STOP

Figure 2.8 - Dry Crank flow chart

TAXI/LINE UP/TAKE OFF

Pre Taxi Checks

(1B-B-15-32-13-00A-131A-A Issue 006)

FCS Pre Flight and Actuator Maintenance Checks

FCS Pre Flight Check (PFC)

The FCS PFC is automatically performed on power up. For FCS RSET, FCS TEST and ACUE format indications, refer to Table , “ACUE Format FCS Indications,” on page 2-19.

Actuator Maintenance Check (AMC)

The AMC is initiated by pressing the FCS TEST button prior to entry into Flight Resident Software (FRS). The AMC is inhibited when the FCCs have entered FRS. For FCS RSET, FCS TEST and ACUE format indications, refer to Table , “ACUE Format FCS Indications,” on page 2-19.

NOTE

ICO will interrupt the AMC and set the controls to a safe position.

After ICO, the FCS TEST must be pressed twice to repeat the AMC. First press will reset the AMC to the start point, at this point the FCS NOGO and FCS AMC AVAILABLE prompts are displayed. Second press will restart the AMC.

Entry into Flight Resident Software (FRS)

The MASS switch must be set to STBY prior to entry into FRS.

The LINS can only align its vertical channel until after FRS entry. This has no effect on the NWS moding, i.e. the NWS will enter the low speed mode. Similar, the FCS should be in FRS prior to select NAV on the ACUE format to allow the IMU to adopt the LINS True Heading.

Upon entering FRS the full FCS mode is available and the controls are set to:

– Take Off Trim (FCS RSET - T/O steady lit) datum position.
– NWS will engage into the low speed mode (NWS legend flashing low - 0.5 Hz, foreplanes at zero position), provided a valid LINS GS signal is available. Otherwise the NWS will enter the medium speed mode by default, which is indicated by the foreplanes being set to the DUMP position.
– The CONFIG is set by default to the appropriate CONFIG (bars lit), provided that <FCS MASS> and <SCAC> are not lit on the DWP.

Following entry into FRS, any manual trim offsets in pitch or roll will cause the TOT legend on the FCS RSET button to flash. Reset can be achieved by:

– Pressing the FCS RSET (TOT steady) button, or
– Advancing either throttle out of the idle position.

No brake prompts should be displayed on the ACUE format. A single brake failure is indicated by a BRAKES NOGO and BRAKE SYSTEM 1 (or 2) FAIL prompt.

Operation of the BARO toggle switch, either UP or DOWN, in excess of 23 seconds will fail the baro set facility (BARO-SET on DWP).

CAUTION

NO DE-SELECTION OF SBY OR SELECTION OF A RADAR TRANSMITTING MODE SHALL BE DONE WHILST ANY PERSONNEL ARE WITHIN THE FIELD-OF-VIEW OF THE RADAR BEAM.

After radar switch on, the radar will default into the standby (SBY) mode of operation following warm-up.

1. ASP ..... Test
2. FCS RSET..... Press
3. GUH ..... Confirm valid heading
4. LOW HT ..... As required
5. XMIT..... Confirm RDR SBY
6. CANOPY ..... CLOSED or VENT

ACUE Format FCS Indications

STATES & ACUE FORMAT DISPLAY							
CONDITION	(0) WAIT FOR PWR ON	(1) WAIT FOR ENG START	(2) WAIT FOR FRS	(3) WAIT FOR TAXI	(4) WAIT FOR T/O	(5) WAIT FOR LDG UP	(6) IN FLIGHT
PFC in progress (Power On)		FCS NOT READY & FCS PRE-FLIGHT BIT IN PROGRESS		Transition to State (3)		N/A	
PFC pass		FCS NOT READY (no HYD)	FCS READY (HYD available)	Not applicable. See FRS engaged.			
PFC NOGO	occult	FCS NOGO PRE-FLIGHT BIT AVAILABLE plus WARNING cue		Not applicable. See FRS engaged.			occult
AMC in progress	ACUE	FCS NOT READY & ACTUATOR BIT IN PROGRESS		Not applicable.			ACUE
AMC pass		FCS READY ACTUATOR BIT AVAILABLE		Not applicable.			
AMC NOGO		FCS NOGO & ACTUATOR BIT AVAILABLE		Not applicable.			
FRS engaged		Not applicable.		ACUE FormatEmpty			

Taxiing

(1B-B-15-32-22-00A-131A-A Issue 006)

General

CAUTION

IF THE CANOPY IS IN THE VENT POSITION (PARTIALLY OPEN) CONFIRM THE SEAT SAFETY LEVER IN SAFE.

NWS modes:

Low mode +/- 43°	NWS legend slow flash (0.5 Hz)
Mid mode +/-28°	NWS legend steadily lit *
High mode +/-10°	NWS legend steadily lit.

* Default mode if LINS has failed or is not in NAV.

CAUTION

HARSH BRAKE APPLICATIONS AT LOW GROUND SPEEDS PARTICULARLY AT AFT CGS CAN CAUSE THE NOSEWHEEL TO BOUNCE TO “IN AIR” BEFORE ONE PART OF THE AIRDATA SYSTEM HAS INITIALIZED. THIS WILL CAUSE THE AIRDATA SYSTEM TO FAIL, AND LATCH THE CONTROL LAWS TO REVERSIONARY MODE (FCS REV WARNING IS LATCHED AS WELL).

NOTE

– A SINGLE BRAKE FAILURE IS INDICATED BY A BRAKES NOGO AND BRAKE SYSTEM 1 (2) FAIL PROMPT ON THE ACUE FORMAT.
– BELOW 50 KTS, IT IS RECOMMENDED TO USE THE GS DISPLAY ON THE HUD.

The fade-in/out is determined by a combination of LINS GS and wheel speed signal.
During low speed taxi Lift Dump is automatically disengaged to ensure no foreplane reflection of the landing lights.

Taxiing with the Nose Wheel Steering (NWS)

The NWS is scheduled automatically in response to a combination of airspeed, aircraft groundspeed from the LINS and wheel speeds from the landing gear computer. The deflection of the nosewheel differs according to three speed dependent schedules (low, medium and high). Hysteresis is incorporated into the slow speed schedule to eliminate any undesirable changeover effects. Aircraft response to rudder pedal inputs is smooth and progressive. Pilot sitting position is very slightly ahead of the nosewheel position and as a result it is easy to follow the desired taxi pattern once the relationship between the visual reference point and the nosewheel has been experienced.
Turn radius in the slow speed mode (high deflection) schedule is approximately 11 m, this allows for good maneuverability in confined areas. Transition to the medium speed schedule during acceleration occurs at 30 kts ground speed and is accompanied by the foreplanes moving from the streamed to the lift-dump position, providing the throttles are within 26 mm of idle. Transition from the medium speed to high speed schedule occurs progressively between 60 and 90 kts airspeed.
Failure of the LINS or wheel speed signals will cause loss of the slow speed high deflection schedule.

Before Take-Off Checks

(1B-B-15-33-01-00A-131A-A Issue 006)

General

The fuel balance (difference in contents between forward and aft main fuel groups) is displayed by the FWD and the REAR GUH fuel indicator on the head-up panel (HUP). Fuel imbalance is indicated by the FUEL FWD or FUEL REAR caption on the ENG- and FUEL formats.
The VENT caption, if displayed should extinguish when the throttles are advanced to above 70 % NL.
When flying with external tanks the pilot shall verify on the Fuel format that the fuel system recognizes that the fuel tanks are present.

1. Instruments .....Check / set
2. Pins .....2 Front / 1 Rear
3. Harness / visor / oxy /fuel .....Check
4. Canopy.....Closed and locked
5. Seat safety lever..... ARMED
6. External lights..... As required

Line Up

(1B-B-15-33-02-00A-131A-A Issue 005)

With PARK BRK OFF and MASS is selected to LIVE, or both throttles are set above IDLE values, the ATCK format is replaced by the ACUE format and the STOR format is replaced by the ENG format. Any caution remaining on the ACUE will prevent a change of MHDD formats to the T/O POF.
Advancing the throttles out of the idle position will automatically reset all trims to zero (T/O lit).

1. JETT..... As required
2. ACUE ..... Check
3. MASS ..... LIVE

Taxi Back

(1B-B-15-32-20-00A-131A-A Issue 003)

Introduction

When taxiing back to the flight line, parking the aircraft and preparing for egress, certain systems and switch selections can be selected off.

Procedure

1. MASS ..... SBY
2. Seat safety lever..... SAFE
3. External lights ..... As required

When at aircraft shelter/parking spot:

4. Systems gang bar ..... Select non essential services to off
5. Engines ..... Shut down one
6. APU ..... Start

When APU running at steady state:

7. Engines ..... Shut down second

If AIM9L Missiles are fitted:

8. Missiles..... Confirm covers/safety pins fitted
9. MASS ..... SAFE

When push back complete and/or ready for shutdown:

10. APU ..... Shut down
11. Gang bars..... Select switches to off
12. Navigation lights..... OFF

Takeoff

(1B-B-15-33-03-00A-131A-A Issue 005)

MAX REHEAT Takeoff Technique

Aircraft acceleration in reheat power is extremely quick. Takeoff data should be considered in respect to the PDM taking into account all relevant factors.

NOTE

In the interest of low pitch oscillations during the take off run it is recommended to release the brakes already at 70% NL.

Holding the aircraft on the brakes, advance the throttles swiftly to the desired condition, as the NL passes 85%, release the brakes with the stick in neutral position, the aircraft will leap forward and the airspeed will increase rapidly. As the airspeed passes 110 KDAS smoothly and progressively apply aft stick of approximately three quarters of stick (75%). Rotation is progressive and predictable allowing easy capture of the desired climb attitude through relaxation of the stick input back to neutral. The desired climb out attitude can initially be controlled by using the E type AOA indicator in the HUD. Once a positive rate of climb has been established, raise the landing gear. Following landing gear retraction the climb bars should be used to control the desired climb attitude.
Directional control during the initial ground run up to rotation speed is achieved by the nosewheel steering (NWS). In order to avoid potential NWS PIOs an instantaneous switch-over from low speed (+/- 43°) to mid speed (+/- 28°) occurs when advancing both throttles near to the Max Dry position . The rudder becomes effective from approximately 70 KDAS onwards.
A slight tendency to overshoot the target AOA is experienced when a snatch to full back stick is used for the rotation, but even in this case there is a good AOA control and any potential overshoot is easily controlled.
Reheat thrust should be cancelled at approximately 250 KDAS. Do not delay landing gear retraction to avoid exceeding the normal landing gear retraction limit (290 KDAS).

After Takeoff

With weight off the nosewheel, the FCS will fade into the airborne mode.
FCS RSET - NWS LEGEND
The NWS legend will extinguish as soon as weight is off the nosewheel.
FCS RSET - T/O LEGEND
The T/O legend will extinguish as soon as weight is off the nosewheel. The LDG indication of the HUD will extinguish.

Rejected Takeoff (Abort)

For rejected takeoff criteria, refer to Abort pag. 3-5.

ENGINE/REHEAT FAILURE DURING TAKEOFF

Refer to Engine Failure During Take-Off pag. 3-6 and to Reheat Failure During Take-Off pag. 3-7.

CLIMB/CRUISE

Normal Climb

(1B-B-15-34-01-00A-131A-A Issue 003)

Description

The normal climb technique is that which results in the maximum range being achieved during the climb to a prescribed altitude.

Procedure

The climb speed is the applicable KDAS until the interception of the corresponding Mach number, then maintain the Mach number.

Normal Climb Speed to Achieve Maximum Range - Engines in Dry

DRAG INDEX	CLIMB AIRSPEED
15, ISA	350 KDAS/0.85M
60, ISA	350 KDAS/0.85M

Minimum Time Climb

(1B-B-15-34-02-00A-131A-A Issue 004)

Description

The performance climb technique is that which results in the minimum time to reach the prescribed altitude.

Procedure

The climb speed is the applicable KDAS until interception of the corresponding Mach number, then maintain the Mach number.

Performance Climb Speed - Engines in Reheat

DRAG INDEX	PERFORMANCE CLIMB AIRSPEED
15, ISA	550 KDAS/0.93M
60, ISA	550 KDAS/0.90M

Cruise

(1B-B-15-34-04-00A-131A-A Issue 003)

Description

The cruise condition is attained when the aircraft has reached its prescribed altitude and entered into straight and level flight. The following tables should be used to determine the optimum altitude to achieve the maximum range using the minimum quantity of fuel for a given mass and drag index.

Procedure

The subsonic cruise data presented in Table , “Cruise Data for Drag Index of 15 at 14 000 kg,” on page 2-22 and Table , “Cruise Data for Drag Index of 60 at 15 000 kg,” on page 2-22 is applicable to two engines operating, for aircraft masses of 14 000 kg and 15 000 kg at ISA.

Cruise Data for Drag Index of 15 at 14 000 kg

ALTITUDE	KG/100 ANM	ANM/100 KG	RANGE SPEED
40 000	333	30.0	0.90 M
30 000	389	25.7	0.74 M
20 000	482	20.7	0.69 M
10 000	626	16.0	0.61 M
Sea Level	784	12.8	0.53 M

Cruise Data for Drag Index of 60 at 15 000 kg

ALTITUDE	KG/100 ANM	ANM/100 KG	RANGE SPEED
40 000	394	25.4	0.87 M
30 000	445	22.5	0.72 M
20 000	547	18.3	0.69 M
10 000	707	14.1	0.60 M
Sea Level	884	11.3	0.50 M

AIR TO AIR REFUELING

In-flight Refueling

(1B-B-15-34-06-00A-131A-A Issue 004)

Description

Prior to in-flight refueling the following FCS in-flight refueling limitations should be observed:

– Speed; 200-300 KDAS/below 0.85M (200- 325 KDAS/below 0.8M when probe extended and locked)
– Altitude; 35 000 ft max
– 0g to +2g
– AOA: 20°.

For obvious safety reasons the LATE ARM switch must be in the safe position and the radar, RADALT, transponder, interrogator and TACAN transmitters must be set to silent mode via the MDE XMIT subsystem.

On selection of the FUEL PROBE switch to OUT, the FCS control laws exit FULL mode and enter in-flight refueling mode. During engagement/ disengagement of the in-flight refueling mode, transient airdata warnings may occur. The normal extension sequence takes between 5 and 20 seconds. If more than 20 seconds elapse a Cat 3 IFR

probe warning is generated (refer to In-flight Refueling Probe Failure pag. 3-21).

With in-flight refueling mode selected the pilot may experience a time delay in pitch response, particularly with large forward stick inputs. Caution should therefore be exercised and stick inputs minimized if oscillations are encountered during in-flight refueling. In addition, significant errors in KDAS, MACH and altitude readouts are present, e.g. ± 20KDAS, ± 0.05M and ±300 ft respectively. The tanker aircraft should be used as an additional reference to speed and altitude.

Once the probe has been successfully deployed, the in-flight refueling ready caption (RDY) will be displayed on the Fuel format and the REFU STRT, REFU STOP and REFU TOT/INT/SIM soft-keys become available for selection. The desired refuelling option (TOT, INT or SIM) may be selected prior to, or during contact. If the RDY caption is not displayed in-flight refueling will not be available. When contact is made with the drogue the refuelling procedure is automatically started. The procedure will stop when either all the selected tanks are full, indicated by the in-flight refueling complete caption (FULL) on the Fuel format, or if contact with the tanker is broken.

With the probe selected out the FCS CG warning limits are relaxed but the pilot will still be informed if an abnormal CG situation occurs, i.e. due to a tank failing to fill. If this occurs, or if any fuel warnings occur, in-flight refueling should be abandoned and the problem diagnosed. The relaxed CG limits may also mask an unfavorable CG situation that will only become apparent when contact with the drogue is broken and the FUEL PROBE switch is selected IN. In this instance the relevant CG warning drills should be performed and the necessary limits observed until the situation is rectified.

If the probe fails to retract, perhaps due to high aerodynamic forces, reduce the airspeed to 200 - 240 kts. If the probe still fails to retract refer to In-flight Refueling Probe Failure pag. 3-21.

In the event of a left utility hydraulics failure prior to an essential in-flight refueling , the probe may be extended by selecting the FUEL PROBE switch to EMGY OUT (refer to In-flight Refueling Probe Failure pag. 3-21).

Procedure

1. Altitude..... Below 35 000 ft
2. Speed ..... 200 to 300 KDAS / below 0.85 M
3. AoA/g..... 20° / 0 to + 2g
4. Late arm ..... Safe
5. XMIT ..... ALL SLNT
6. Nav and a/coll lights... As required
7. FUEL PROBE..... OUT

When RDY is displayed on the FUEL format:

CAUTION

A TIME DELAY IN PITCH RESPONSE, PARTICULARLY WITH LARGE FORWARD STICK INPUTS, MAY LEAD TO OVER CONTROLLING. CAUTION SHOULD BE EXERCISED AND STICK INPUTS MINIMIZED IF OSCILLATIONS ARE ENCOUNTERED DURING IN-FLIGHT REFUELING .

8. FUEL format ..... REFU options as required

NOTE

In-flight refueling may be interrupted or restarted via the REFU/STOP/STRT soft-key.

After refueling:

9. FUEL PROBE ..... IN
10. XMIT ..... ALL NORM
11. Nav and a/coll lights... As required

DESCENT/RECOVERY

Holding

(1B-B-15-36-02-00A-131A-A Issue 004)

Holding Pattern

The standard no-wind holding pattern is flown by a specific holding course inbound to the IAF/Holding Fix with a 180° turn/30° bank to the right flying outbound to parallel the holding course, making another 180° turn to the right to intercept and follow the holding course to the fix inbound. Standard no-wind length of inbound legs is 1 minute at or below 14 000 ft MSL and 1 1/2 minutes above 14 000 ft MSL pattern altitude. In a nonstandard no-wind holding pattern turns are flown to the left.

Holding Pattern Airspeed

ICAO Holding Speed requirements depend on altitude, weather conditions or additional local requirements (refer to Table , “ICAO Holding Speeds,” on page 2-24), flying standard rate or 30° bank turns if not compensating for wind. Climbs and descends will be performed expeditiously, consistent

with safety and normally at a maximum rate of 2000 fpm. If altitude change is less than 4 000 ft, use no more than one half of the altitude change as rate of climb/descend.

ICAO Holding Speeds

	Normal	Turbulence
Up to FL 140 *	230 KDAS	280 KDAS
FL 140 to FL 200	240 KDAS	280 KDAS/0.8 M
FL 200 to FL 340	265 KDAS	280 KDAS/0.8 M
Above FL 340	0.83 M	0.83 M

* 220 KDAS max within London TMA.

Holding Pattern Entry

Approximately 5 minutes prior reaching a IAF/ Holding Fix, ATC should issue letdown or holding instructions. Within 3 minutes of reaching the fix, airspeed should be reduced to penetration or holding speed. Upon initial station passage of the Holding Fix the a/c is considered to be in the holding pattern.

When entering a holding pattern and if cleared for penetration without delay, the pilot shall:

– Navigate as to overfly the IAF/Holding Fix according to published letdown procedure.
– Descent so as to reach the initial approach altitude or the assigned altitude when arriving at the IAF.
– Decelerate so as to arrive at the Initial approach Fix with the penetration speed of 300 KDAS.

When entering holding pattern and if instructed to hold, the pilot shall:

– Decelerate so as to arrive at the IAF/ Holding Fix with the holding speed of 250 KDAS.
– Enter the holding pattern as published on high altitude approach charts and/or as instructed.
– Report with the following radio calls:
  - ENTERING THE HOLDING PATTERN when establishing within the prescribed holding pattern track and being definitely able to stay within the holding pattern airspace for further maneuvers.
  - APPROACHING THE IAF WITHOUT HAVING CLEARANCE when approximately. 3 miles or 30 seconds out from IAF without having received any clearance to penetrate or instructions to hold.
  - LEAVING THE IAF when leaving IAF.
  - LEAVING ALTITUDE when commencing descent from IAF altitude or a given altitude.

Entry Turn Directions

They are determined by the angular difference between the holding course and the aircraft heading at initial passage of the Holding Fix as follows:

Within 70°

If the holding course is within 70° of the aircraft heading, turn outbound on the holding side to parallel the holding course. Upon completion of the outbound leg, proceed direct or intercept the holding course to the fix.

Not within 70°

If the holding course is not within 70° of the aircraft heading, turn outbound in the shorter direction to parallel the holding course. If this turn places you on the non-holding side, either parallel or attempt to intercept the holding course outbound. If you are on the non-holding side or on the holding course at the completion of the outbound leg, turn toward the holding side, then proceed direct or intercept the holding course to the fix.

Teardrop

The teardrop entry may be used at pilot discretion when entering the holding on a heading conveniently aligned with the selected teardrop course. Upon reaching the holding fix, turn on the holding side and proceed on an outbound track not to exceed 45° from the outbound course. Then continue to intercept the selected teardrop course outbound.

Descent/Recovery

(1B-B-15-36-03-00A-131A-A Issue 006)

General

The Descent/Recovery checks should be accomplished at a time when mission/flight demands are not critical.
Before descending to low level or recovery for landing carry out normal system checks. These should include:

– A check of all displays such as HUD / MHDDs / GUH
– Altimeters -pressure and radar altimeter

– Fuel contents and balance, MHDD and GUH indications
– FCS status
– CONFIG status
– AIRDRIVE position in AUTO
– Landing light on.

Types of Descent

INSTRUMENT DESCENT	
Speed	300 KDAS/0.9M
Throttles	Idle
Airbrake	IN
Range Descent *	
Speed	250 KDAS/0.9 M
Throttles	Idle
Airbrake	In
Rapid Descent *	
Speed	450 KDAS/0.9 M
Throttles	Idle
Airbrake	Out

* To determine distance covered, time and fuel used to descend from altitude to sea level or between any two altitudes, refer to AER(EP).1F-EF2000(T)-1-1.

TACAN Approach

(1B-B-15-36-05-00A-131A-A Issue 002)

TACAN Penetration

Prior reaching IAF, or starting descent, obtain latest weather, alternate information, QNH or QFE and perform the “Pre Descent Check” according to the Flight Crew Checklist (refer also to Descent/ Recovery pag. 2-24, Descent/Recovery). If no holding is required it may be feasible to be convenient aligned with the approach track for immediate penetration when reaching the fix. Therefore a lead point should be calculated, preferable on the holding side and has to be requested as maneuvering airspace with ATC. When at the IAF and commencing descent:

– Set throttles to about 70 % NL.
– Lower the nose approximately 10°.
– Extend airbrake if required when approaching 300 KDAS.
– Maintain 300 KDAS.
– Establish rate of descent of approximately 3000 to 5000 fpm.

For level off, reduce rate of descent at 2000 ft above desired level-off altitude to about 2000 fpm and allow airspeed to decrease. Airbrake retraction is dependent upon how soon the aircraft must be slowed down. Normally airbrake should be retracted 2000 ft above level-off. If on a straight in approach and close (10 to 12 NM) to the final approach fix, retract airbrake approaching 250 KDAS.

TACAN Approach

TACAN approaches are non-precision approaches and should be monitored by Radar. The final approach starts at the Final approach Fix (FAF) and ends at the missed approach point (MAP). Maintain 250 KDAS until approximately 10 to 12 NM from touchdown. At this point extend the LDG and decelerate as to reach final approach speed at least one mile prior FAF. Upon reaching the FAF, start descent to published minimum descent altitude (MDA). Normally, an expeditious descent is recommended. If visual runway contact is not established at MAP or if a safe landing cannot be performed, execute a missed approach as published or as directed. Refer to Circling Approach pag. 2-26, for Circling Approach.

Radar/GCA Approach

(1B-B-15-36-07-00A-131A-A Issue 002)

Radar Penetration

Normally the type of enroute descent will depend on numerous factors. If fuel at destination is critical and IDLE descent may be considered. Normally airspeed is dependent on type of descent, e.g Normal descent, rapid descent, minimum fuel max range descent. Normal descent would be to hold 300 KDAS with or without airbrake. For minimum fuel max range descents reduce power to hold approximately 250 KDAS (This procedure is not recommended in IMC). If ATC calls for a rapid descent airbrake will be required to hold the speed subsonic i.e. at or below 0.9 Mach.

Types of Approaches

There are basic types of approaches, the Precision and the Surveillance Approach. The precision approach provides the pilot with precise course, glide slope and range information. For the surveillance approach course, range and corresponding altitude information are provided and it is classified as a non-precision approach.

Precision Approach

Use a minimum of 70 % NL power for descent. Airbrake may be used to descent instead of a power change prior to LDG extension. After LDG extension adjust power for descent and avoid the use of the airbrake.

Downwind leg is flown at 250 KDAS, LDG UP. When wings are level on Base Leg (within 10 NM of field), lower the LDG and add power as necessary to maintain 180 KDAS minimum. When established on final, slow down to computed AOA/Speed relationship. If a straight in approach is being made lower LDG at 10 to 12 NM in the same manner as done on the base leg and slow down to final approach speed. If no definite base leg heading has been established prior to dog leg or final, lower the LDG and reduce speed to 180 KDAS within 10 NM of field. When intercepting the glide path, establish the desired rate of descent (500 to 700 fpm) reduce power as required and maintain the computed final speed by adjusting pitch and power accordingly.

Surveillance Approach

This approach is flown using the same instrument technique as the Precision Approach. To maintain on glide path the controller will give altitudes corresponding with distance from touchdown.

Types of Pattern

The two most common traffic patterns are Rectangular Pattern and the Straight in Approach. The straight in approach is the most desirable since it requires less time and fuel. Regardless of type, the radar approach is divided into two phases - the traffic pattern and the final approach.

The traffic pattern includes all maneuvering prior to a point approximately 7 NM from touchdown on the final approach course. For turns during the traffic pattern phase, establish an angle of bank not to exceed 30°. Airspeed in the pattern should be 250 KDAS, while the rate of climb/descent should normally not exceed 1000 fpm.

The final approach phase begins at approximately 7 NM and ends when the landing is completed or the missed approach commenced.

Voice Procedures

The Radar approach is predicated entirely upon voice instructions from the approach controller or radar controller. repeat all headings, altitude and altimeter settings until the final controller advises “do not acknowledge further transmissions”. Transmissions should be kept brief and specific.

Circling Approach

(1B-B-15-36-08-00A-131A-A Issue 001)

A circling approach will be flown staying clear of clouds and keeping the runway in sight at the published minimum approach altitude. This altitude will be maintained until landing is assured. Minimum airspeed during circling approach will be radar base leg airspeed with gear down until established on final.
If unable to complete a safe approach initiate a GO AROUND and execute a Missed Approach or follow given instructions.

Go Around

(1B-B-15-36-09-00A-131A-A Issue 001)

The decision to go around should be made as early as possible. When the decision is made advance both throttles to desired power setting. As the aircraft accelerates, rotate the nose to a climbing attitude and when altitude and VSI indicate a positive climb, continue with the after takeoff checks.

Missed Approach

(1B-B-15-36-09-01A-131A-A Issue 001)

Execute missed approach at published landing minimum or as directed by ATC. If another approach is desired:

– Accelerate to 250 KDAS with 1500 to 2500 ft/ climb.
– Reduce power to maintain 250 KDAS.

LANDING

Pre Landing

(1B-B-15-36-10-00A-131A-A Issue 006)

Introduction

Confirm correct CONFIG OVRD setting, meaning:

– 'A` for fully automatic scheduling. All Fuel/Store interface signals function.
– 'B` Fuel/Store interface signals are fixed to values representing store group 1 at 14 tonnes.
– 'C` Fuel/Store interface signals are fixed to values representing store group 1 at 16 tonnes.

The relevant bar is lit.
Routine operations should be to cross-check the AOA vs airspeed on approach for the following information:

– Aircraft mass
– Expected approach speed
– Planned AOA on final approach.

Pre Landing

The Aircraft Mass can be obtained by adding the remaining fuel (kg) as displayed on the HUP and the FUEL format to the Basic Mass Empty (BME).

The Expected Approach Speed for various aircraft masses can be determined from the relevant Performance Data Charts in the Performance Data Manual. Speeds are given for the standard 13° AOA approach assuming 13 000 kg. Variations in speeds due to variations of aircraft masses can be obtained by interpolation and extrapolation, respectively.

NOTE

HUD AOA in APPR/LDG POF is a E-type indicator, representing 12, 14 and 16° AOA respectively.

If the expected approach speed minus the allowable error is achieved before the expected AOA is achieved (13° standard approach) the pilot will perceive this as an anomaly between AOA and the airspeed, and that either the AOA is under-reading or the airspeed readout is under-reading; in this case the airspeed should be maintained. Conversely, if the target AOA is achieved before slowing down to the expected approach speed plus allowable error, an anomaly exists in either the AOA or airspeed is overreading. Again, the current airspeed should be maintained.

In cross wind conditions the crabbed approach method is recommended.

The approach and landing technique assumes:

– The airbrake is IN (retracted) and the leading edge (L/E) is IN (retracted) whith the landing gear DOWN at an AOA < 17 units.

With the landing gear down the control law mode is as follows:

– Non-carefree handling in full mode. AOA limiter of 0°/25° and g limiter of 0/+4 g implemented.
– Pitch rate demand mode (Q demand).
– Roll authority for the clean a/c of 80 deg/sec.
– Roll authority for a/c with tanks ~ 125 deg/sec. with full tanks up to 200 deg/sec. with empty tanks
– Improved lift/increased drag in the approach phase through pre-setting of an approach schedule foreplane (+2 deg).
– Airbrake is fully available with no AOA dependent inhibit, i.e. the airbrake deflection authority is fixed to fully extended independent of AOA to prevent airbrake cycling on approach.
– Foreplane derotation bias is enabled, ready for activation on mainwheel touchdown.

1. Landing gear.....DOWN, 3 green / 3 D

Airspeed / AOA check on approach:

145 KDAS at 13 000 kg / 14 AOA +/- 5 KDAS / 1000 kg above / below.

For crosswinds from 25 to 30 kts (asymmetric config and wind from light side): 12° AOA (max)

Normal Landing

(1B-B-15-36-11-00A-131A-A Issue 004)

General

Check 3 greens and the 3 D in the HUD.

Approach and Landing:

– Prior to the approach: When below 290 KDAS lower the landing gear. Simultaneous operation of the LDG and the airbrake should be avoided.

– During the approach stabilize the speed on a 2.5 to 3° glide path, to achieve an approach speed equivalent to aircraft gross-weight and expected AOA. To control the AOA an “E” type indicator represents AOA for landing. 13° AOA approach is recommended.

With the landing gear DOWN the aircraft is not-carefree, although a +25° AOA and +4/-0 g limiter is implemented.

Landing:

– No flare maneuver is necessary to be carried out because the aircraft flares naturally itself when close to the ground. Normal AOA for landing should be 15°.
– The aircraft de-rotates nicely with slight forward stick. Half forward stick may be used to assist or quicken the de-rotation.
– At mainwheel touch down reduce power to idle and depoly the brake chute. Use Full Forward Stick (FFS) until the brakes are applied. Optimum braking is achieved by adhering to the sequence of selecting the brake chute before application of the wheel brakes.
– Pedal application up to full deflection may be used. At speeds less than 9 kts GS smooth pedal inputs shall be applied (anti skid drop-out speed).
– With all wheels on the ground and both throttles at IDLE, lift dump will be automatically activated.
– Following all wheels on the ground and both throttles at IDLE the nozzles are opened to 100% Aj, independent of lift dump selection.
– When normal taxi speed is reached check the airbrake in, if used, and jettison the brake chute (to avoid damage to the chute).

The NWS will be engaged automatically with WONW.

Single Engine Landing

The engine bleed air power is set to achieve the same level than with two engines at IDLE to avoid possible gearbox oscillation below 60% with possible associated loss of electric.

Single engine landing should not lead to problems.

Single engine taxi (RH or LH engine shut down) is possible, since the bleed air power is set to a value which guarantees a cross-bleed level sufficient to keep the relevant GB running.

Crosswind Landing

(1B-B-15-36-12-00A-131A-A Issue 006)

NOTE

Do not use sharp full pedal input to kick off drift in high crosswinds. A sharp wing drop which is difficult to predict has to be expected.

Carefully compensate for crosswind prior to landing in order to avoid undershooting or overshooting. The crosswind can be compensated by using the crabbed approach technique. Prior landing the kick-off drift maneuver should be applied, using gently increasing rudder input until touchdown. The delay between kicking off drift and main wheel touch down should be minimized.

Ensure directional control is established before deploying the brake chute. Use of the brake chute intensifies the weather vane effect. If directional problems occur during landing with the brake chute deployed, the brake chute should be jettisoned. Since the nose gear will rapidly assume a position relative to the rudder pedals, nose gear steering should be initiated with the udder pedals at or near the neutral position. The most important aspect of directional control under crosswind conditions is keeping the aircraft aligned with the runway rather than trying to correct back to the runway centerline after it has deviated.

For cross wind limitations refer to Section 5.

Landing on Slippery Runway

(1B-B-15-36-13-00A-131A-A Issue 003)

Wet or icy runways pose severe problems in directional control and braking effectiveness. On wet runway these are primarily the result of hydroplaning where the tire rides on a thin layer of water and produces little or no traction.

Hydroplaning and ice present essentially the same problems. Gross weight should be reduced to the minimum practicable. Immediately after touchdown retard the throttles to idle. Do not attempt to align the aircraft heading with the runway as this will result in a drift off the runway if the aircraft is sliding or hydroplaning. Maintain full forward stick to increase nosewheel traction. When the aircraft is aligned with the runway centerline deploy the brake chute. Be prepared to jettison the brake chute if the weather-vaning effect interferes with maintaining the track straight down the runway.

In general, the technique described under normal landing (Normal Landing pag. 2-27) should be applied when practicable.

Aerodynamic braking may be applied with or without brake chute depending on environmental conditions, e.g. cross-wind. After nose wheel on the ground gentle braking should be used. Consider approach end or departure end cable engagement.

Touch and Go Landing

(1B-B-15-36-15-00A-131A-A Issue 004)

Touch and Go/Roller Landing

NOTE

The term `Roller Landing' applies when the nose wheel is lowered onto the runway; the term `Touch and Go' applies when only the main wheels contact runway.

After touchdown maintain sufficient back stick pressure to hold the nose wheel off the ground. The airbrake should be retracted, if used, when smoothly advancing the throttles to MAX DRY. At the computed lift off speed rotate the aircraft to achieve 15° AOA until the aircraft lifts off again. When safely airborne hold 13° to 15° AOA and raise the LDG.

In the case where manual trim offsets have been applied prior to roller landings all manual applied trim offsets will fade to the datum (TOT) on nose wheel touchdown with one throttle at least above idle. Following touch and go landings (nose wheel off the ground) the manual applied trim offsets will be retained.

Braking Technique

(1B-B-15-36-14-00A-131A-A Issue 004)

General

CAUTION

DO NOT APPLY BRAKES WITH THE NOSE WHEEL OFF THE GROUND.

Normal sequence following main wheel touchdown should be:

– Deploy the brake chute *.
– Assist de-rotation by applying slightly forward stick input.
– Following nose wheel on the ground, initiate full forward stick
– Apply brakes once below MBS
– Up to full aft stick may be applied to assist braking action taking care that the nose wheel remains firmly on the ground.

* Brake chute may be deployed either at or after main wheel touchdown.

After brake chute deployment and nose wheel on the ground, full forward stick shall be applied until steady braking is achieved. When steady braking is reached smooth back stick inputs are recommended. Normal braking should only be applied once below Maximum Braking Speed (MBS). Degraded performance of the brakes must be anticipated when used above MBS.

For calculation of Max Braking Speed refer to AER(EP).1F-EF2000(T)-1-1.

NOTE

Stepped brake application are to be avoided.

Pedal application to full deflection is cleared. At speeds less than 9 kts GS smooth pedal inputs shall be applied (anti-skid drop-out speed).

Aerodynamic Braking

Aerodynamic braking shall be used to safe brake life whenever possible. This technique may be applied under normal conditions, runway length permitting and should also be applied under the following emergency conditions, when possible:

– Landing with a known blown nose wheel
– Landing with known NWS failures.
– Approach-end-cable is recommended but not available, or the cable exceeds the limits of the aircraft/arresting system.

Aim to touchdown at the proper airspeed near the front end of the runway to use its full length.

– Aerodynamic braking should not exceed 15° AOA for speeds from touchdown speed down to 90 KDAS.
– With or without airbrake deployed.
– With or without deployment of the brake chute following main wheels on the ground.

Aerodynamic braking is not cleared for the following failure cases:

– Longitudinal CG in zone 1 (hazardous CG)
– Longitudinal CG in zone 2 (critical CG)
– Fuel/Store system failed, or
– FCS Worst case failure.

Cable Engagement

Approach-End-Cable

If an approach-end-cable engagement is planned, lower the hook on approach. Following touchdown, reduce throttles to IDLE, and de-rotate prior to cable engagement. Aim for the center of the cable with the nose wheel on the ground. Release the brakes, if used, prior cable engagement.

Departure-End-Cable

If a departure-end-cable engagement is required, lower the hook 1000 ft before the cable and aim for the center of the cable. Release brakes, if applicable, prior cable engagement.

AFTER LANDING

After Landing

(1B-B-15-36-16-00A-131A-A Issue 007)

When normal taxi speed is reached select the airbrake in, when used, and jettison the brake chute.

Normal taxi back should be performed with both engines running.

In the case of single engine taxi and the live engine drops below 75% (NH) the GB speed is controlled at 30% instead of 60%. This algorithm is active only on the ground and allows to perform single engine taxi with steering available if the left engine is shut down.

1. Brake chute.....Jettison
2. Seat safety lever .....SAFE
3. MASS.....STBY
4. XMIT .....ALL SLNT
5. External lights .....As required

Engine Shut Down

(1B-B-15-36-17-00A-151A-A Issue 006)

On engine shut down Lift Dump is set to “engaged” (DUMP) to ensure that the foreplanes are parked in a position which does not interfere with the ladder deployment.

1. PARK BRK.....ON

NOTE

– DO NOT DISCONNECT THE LSCA MAN PORTION UNTIL ALL AC POWER HAS BEEN SWITCHED OFF.
– BATT SWITCH MUST BE SELECTED TO OFF WITHIN 2 SECONDS OF FCS TEST ACTIVATION.

If APU GEN not required:

2. L & R throttle .....HP SHUT
3. SECURE DATA.....ERASE when required
4. FCS TEST.....Press
5. BATT.....OFF (within 2 sec.)
6. MASS.....SAFE
7. PDS / VVR .....Remove

If APU GEN required:

2. L or R throttle .....HP SHUT
3. MASS.....SAFE
4. APU.....START, confirm boxed
5. L & R BOOST PUMPS .....OFF
6. Throttle (live engine) ..HP SHUT

RECOVERY DATA

Recovery Data

(1B-B-15-31-21-00A-131A-A Issue 003)

Recovery from Sea Level - Two Engines Operating

Recovery from sea level with two engines operating, drag indexes of 15 and 60 and given remaining fuel loads are presented in tabular form in Table , “DI 15 Recovery From Sea Level - 2 Engines,” on page 2-31 and Table , “DI 60 Recovery From Sea Level - 2 Engines,” on page 2-33 respectively . The tables provide data that show the total distance in nautical miles (nm) from base, the optimum altitude (x 1000 ft) and the Mach number. Also shown is the descent range to 1000 ft in nm and the fuel consumption in (kg) to complete the recovery.

Range and Endurance - Two Engines Operating

Range and endurance with two engines operating, drag indexes of 15 and 60 and given remaining fuel loads are presented in tabular form in Table , “DI 15 Range and Endurance - 2 Engines,” on page 2-31 and Table , “DI 60 Range and Endurance - 2 Engines,” on page 2-34 respectively . The tables provide data that show the Mach number, the fuel flow rate (kg/min) and distance travelled per 100 kg of fuel used (nm/100 kg) for Maximum Range. Also shown is the Mach number and the fuel flow rate (kg/min) to achieve Maximum Endurance.

Recovery from Sea Level - One Engine Operating

Recovery from sea level with one engine operating, drag indexes of 15 and 60 and given remaining fuel loads are presented in tabular form in Table , “DI 15 Recovery From Sea Level - Single Engine,” on page 2-32 and Table , “DI 60 Recovery From Sea Level - Single Engine,” on page 2-35 respectively . The tables provide data that show the total distance in nm from base, the optimum altitude (x 1000 ft) and the Mach number. Also shown is the descent range to 1000 ft in nm and the fuel consumption in (kg) to complete the recovery.

Range and Endurance - One Engine Operating

Range and endurance with one engine operating, drag indexes of 15 and 60 and given remaining fuel loads are presented in tabular form in Table , “DI 15 Range and Endurance - Single Engine,” on page 2-32 and Table , “DI 60 Range and Endurance - Single Engine,” on page 2-36 respectively . The tables provide data that show the Mach number, the fuel flow rate (kg/min) and distance travelled per 100 kg of fuel used (nm/100 kg) for Maximum Range. Also shown is the Mach number and the fuel flow rate (kg/min) to achieve Maximum Endurance.

Drag Index 15 Recovery Tables

DI 15 Recovery From Sea Level - 2 Engines

FUEL (KG)	DIST (NM)	OPT ALT (FT)	MACH	DESCENT RNG (NM)	FUEL USED (KG)	SL DIVERSION	
						FUEL (KG)	MACH
1600	50	17 000	0.67	26	355	417	0.53
	100	27 000	0.70	49	605	832	0.53
	150	32 000	0.78	66	807	1242	0.52
	200	32 000	0.77	66	1003	1645	0.52
	250	32 000	0.76	66	1194	----	0.51
	300	32 000	0.76	66	1382	----	0.51
3600	50	15 000	0.69	23	369	428	0.55
	100	29 000	0.79	54	642	853	0.55
	150	31 000	0.80	61	836	1275	0.54
	200	32 000	0.81	64	1075	1695	0.54
	250	32 000	0.81	64	1285	2112	0.54
	300	32 000	0.80	65	1489	2526	0.53

NOTE

- With gear down at 290 KDAS fuel flow is 76 kg/min.
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent)
- Climb speed 350 KDAS / 0.85 M

DI 15 Range and Endurance - 2 Engines

FUEL (KG)	ALT (FT)	MAX RANGE			MAX ENDURANCE	
		MACH	KG/MIN	NM/100KG	MACH	KG/MIN
1600	0	0.53	48.6	12.0	0.31	38.0
	10 000	0.62	43.8	15.0	0.38	34.9
	20 000	0.70	36.8	19.4	0.50	31.2
	30 000	0.76	31.2	23.8	0.63	28.5
	40 000	0.90	31.1	27.6	0.75	28.7
3600	0	0.55	51.9	11.7	0.34	41.5
	10 000	0.65	47.4	14.5	0.41	38.5
	20 000	0.70	38.4	18.6	0.53	34.5
	30 000	0.80	35.3	22.2	0.68	31.6
	40 000	0.90	34.3	25.0	0.82	33.6

DI 15 Recovery From Sea Level - Single Engine

FUEL (KG)	DIST (NM)	OPT ALT (FT)	MACH	DESCENT RNG (NM)	FUEL USED (KG)	SL DIVERSION	
						FUEL (KG)	MACH
1600	20	7000	0.57	9	137	152	0.51
	40	12 000	0.60	16	264	302	0.50
	60	18 000	0.66	26	377	454	0.50
	80	20 000	0.68	29	479	605	0.50
	100	22 000	0.70	32	575	754	0.50
	120	24 000	0.70	36	668	903	0.50
	140	25 000	0.70	38	758	1051	0.50
	160	26 000	0.70	40	845	1199	0.50
3600	20	6000	0.59	7	141	160	0.54
	40	11 000	0.63	15	277	318	0.53
	60	17 000	0.69	24	398	476	0.53
	80	18 000	0.70	26	509	634	0.53
	100	20 000	0.70	30	616	788	0.53
	120	20 000	0.70	30	719	943	0.53
	140	23 000	0.70	35	819	1098	0.52
	160	25 000	0.70	39	916	1253	0.52

NOTE

- With gear down at 290 KDAS fuel flow is 72 kg/min.
- Climb speed 350 KDAS / MAX DRY
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent)
- Applicable to a windmilling or seized engine.

DI 15 Range and Endurance - Single Engine

FUEL (KG)	ALT (FT)	MAX RANGE			MAX ENDURANCE	
		MACH	KG/MIN	NM/100KG	MACH	KG/MIN
1600	0	0.51	42.6	13.2	0.32	33.5
	5000	0.55	40.8	14.6	0.35	32.7
	10 000	0.60	39.4	16.1	0.39	32.0
	15 000	0.64	37.0	18.0	0.45	31.1
	20 000	0.69	35.0	20.1	0.50	30.0
	25 000	0.70	31.5	22.2	0.57	29.5
3600	0	0.54	47.1	12.6	0.34	37.5
	5000	0.58	45.0	13.9	0.37	36.7
	10 000	0.62	42.6	15.4	0.43	35.9
	15 000	0.67	40.7	17.2	0.48	34.8
	20 000	0.70	37.5	19.0	0.54	33.9
	25 000	0.70	34.1	20.6	0.62	33.2

Drag Index 60 Recovery Tables

DI 60 Recovery From Sea Level - 2 Engines

FUEL (KG)	DIST (NM)	OPT ALT (FT)	MACH	DESCENT RNG (NM)	FUEL USED (KG)	SL DIVERSION	
						FUEL (KG)	MACH
1600	50	18 000	0.67	25	384	464	0.50
	100	28 000	0.70	46	653	924	0.50
	150	31 000	0.72	54	883	1380	0.49
	200	32 000	0.73	57	1106	----	0.50
	250	32 000	0.72	57	1324	----	0.50
	300	32 000	0.72	57	1538	----	0.50
3600	50	17 000	0.69	24	400	483	0.52
	100	30 000	0.76	51	697	963	0.52
	150	31 000	0.78	54	944	1436	0.51
	200	32 000	0.79	56	1184	1905	0.51
	250	32 000	0.78	56	1421	2370	0.50
	300	32 000	0.78	56	1655	2831	0.50
5600	50	17 000	0.69	24	423	504	0.54
	100	29 000	0.79	48	740	995	0.54
	150	30 000	0.80	50	1006	1486	0.53
	200	31 000	0.80	53	1267	1972	0.53
	250	32 000	0.80	56	1524	2455	0.52
	300	32 000	0.80	56	1776	2934	0.52

NOTE

- With gear down at 290 KDAS fuel flow is 83 kg/min.
- Climb speed 350 KDAS / 0.85 M
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent).

DI 60 Range and Endurance - 2 Engines

FUEL (KG)	ALT (FT)	MAX RANGE			MAX ENDURANCE	
		MACH	KG/MIN	NM/100KG	MACH	KG/MIN
1600	0	0.50	51.3	10.7	0.31	40.7
	10 000	0.60	47.5	13.4	0.38	37.6
	20 000	0.69	40.7	17.3	0.50	34.1
	30 000	0.73	33.6	21.3	0.62	31.4
	40 000	0.87	34.6	24.0	0.73	32.0
3600	0	0.53	56.4	10.3	0.33	44.5
	10 000	0.61	50.2	12.9	0.40	41.4
	20 000	0.70	43.0	16.6	0.53	37.6
	30 000	0.78	38.6	19.8	0.67	34.8
	40 000	0.90	39.7	21.6	0.79	37.7
5600	0	0.55	60.7	10.0	0.35	48.3
	10 000	0.64	54.7	12.4	0.43	45.2
	20 000	0.70	44.9	15.9	0.56	41.1
	30 000	0.80	42.4	18.5	0.70	38.3
	40 000	0.90	45.2	19.0	0.86	44.6

DI 60 Recovery From Sea Level - Single Engine

FUEL (KG)	DIST (NM)	OPT ALT (FT)	MACH	DESCENT RNG (NM)	FUEL USED (KG)	SL DIVERSION	
						FUEL (KG)	MACH
1600	20	7000	0.55	8	156	173	0.50
	40	12 000	0.59	15	300	344	0.49
	60	16 000	0.62	20	432	517	0.49
	80	19 000	0.65	25	552	688	0.49
	100	21 000	0.67	28	667	858	0.49
	120	22 000	0.68	29	777	1027	0.48
	140	23 000	0.69	31	884	1196	0.48
	160	24 000	0.70	32	989	1365	0.48
3600	20	7000	0.58	8	162	181	0.52
	40	11 000	0.61	14	316	360	0.52
	60	15 000	0.65	19	457	540	0.51
	80	18 000	0.68	24	587	718	0.51
	100	20 000	0.70	27	711	897	0.51
	120	20 000	0.70	27	830	1073	0.51
	140	21 000	0.70	28	946	1250	0.50
	160	22 000	0.70	30	1062	1425	0.50
5600	20	5000	0.59	5	166	190	0.54
	40	9000	0.62	11	331	377	0.54
	60	13 000	0.66	17	482	565	0.54
	80	16 000	0.69	21	623	748	0.54
	100	17 000	0.70	23	756	932	0.53
	120	18 000	0.70	24	886	1116	0.53
	140	20 000	0.70	27	1013	1300	0.53
	160	20 000	0.70	27	1137	1483	0.53

NOTE

- With gear down at 290 KDAS fuel flow is 83 kg/min.
- Climb speed 350 KDAS / MAX DRY
- Fuel used values do not include a landing allowance
- Descend at 250 KDAS, IDLE power, airbrake in (range descent)
- Applicable to a windmilling or seized engine

DI 60 Range and Endurance - Single Engine

FUEL (KG)	ALT (FT)	MAX RANGE			ENDURANCE	
		MACH	KG/MIN	NM/100KG	MACH	KG/MIN
1600	0	0.50	47.6	11.6	0.32	36.6
	5000	0.53	44.9	12.8	0.35	35.8
	10 000	0.58	43.6	14.1	0.38	35.1
	15 000	0.62	41.1	15.7	0.43	34.4
	20 000	0.67	39.2	17.5	0.50	33.5
	25 000	0.70	36.3	19.3	0.56	33.2
3600	0	0.52	51.7	11.1	0.34	40.8
	5000	0.56	49.5	12.2	0.37	40.0
	10 000	0.61	47.9	13.5	0.40	39.3
	15 000	0.66	45.9	15.0	0.48	38.6
	20 000	0.70	43.1	16.6	0.53	37.7
	25 000	0.70	38.9	18.0	0.59	37.3
5600	0	0.55	56.8	10.6	0.35	45.0
	5000	0.59	54.2	11.8	0.39	44.2
	10 000	0.64	52.4	13.0	0.44	43.5
	15 000	0.69	50.1	14.3	0.51	42.6
	20 000	0.70	45.4	15.8	0.56	41.8
	25 000	0.70	42.2	16.6	0.66	41.8

AER(EP).1F-EF2000(T)-1

SECTION 3 - EMERGENCY PROCEDURES

TABLE OF CONTENTS

Title	Page
ADVICE	3-2
Advice	3-2
GROUND EMERGENCIES	3-3
Ladder not Locked	3-3
ABANDONING	3-4
Emergency Ground Egress	3-4
Ejection	3-4
TAKE OFF EMERGENCIES	3-5
Abort	3-5
Tire Failure During Take-off	3-6
Engine Failure During Take-Off	3-6
Reheat Failure During Take-Off	3-7
Engine Performance	3-7
FIRES	3-7
APU Fire on Ground	3-7
Engine Fire on Ground	3-7
Engine Fire during Take-Off	3-8
Engine Fire in Flight	3-9
FLAMEOUT/RELIGHT	3-9
Double Engine Flame-out	3-9
Single Engine Flameout	3-10
Assisted Relight	3-11
ENGINE FAILURES IN FLIGHT	3-11
Engine Vibration/Mechanical Failure	3-11
Engine Oil Pressure Low	3-12
Engine Oil Overtemperature	3-12
Engine Surge	3-13
ENGINE CONTROL SYSTEM FAILURES	3-13
DECU Failure	3-13
Engine Control System Failure	3-14
Reheat Failure	3-14
SPS Computer Failure	3-16
SPS Air Leak	3-17
FUEL SYSTEM FAILURES	3-17
Fuel Supply Low Pressure	3-17
Low Fuel	3-17
Fuel Transfer Failure	3-18
Fuel Over Temperature	3-18
Fuel Transfer Valve Failure	3-19
Fuel Balancing	3-19
Fuel Vent Failure	3-20
Fuel Computer Failure	3-20
Fuselage Fuel Leak	3-21
In-flight Refueling Probe Failure	3-21
ELECTRICAL SYSTEM FAILURES	3-22
Double AC Generator Failure	3-22
Single AC Generator Failure	3-23
Essential DC Failure	3-23
Electrical Level 2 Failure	3-24
Electrical Level 1 Failure	3-24
Battery Over Temperature	3-25
AC Generator Over Temperature	3-25
GEARBOX FAILURE	3-25
Gearbox Failure (incl. Services lost)	3-25
Gearbox Overtemperature	3-28
Power Offtake Shaft Failure	3-28
SPS Overpressure	3-29
ATS/M Failure	3-29
HYDRAULIC SYSTEM FAILURES	3-29
Double Hydraulic Failure	3-29
Single Hydraulic Failure	3-30
Double Utility Failure	3-31
Single Utility Failure	3-32
Hydraulic Over Temperature	3-32
Air in Hydraulics	3-33
FCS/AIRDATA FAILURES	3-33
FCS/Airdata Failures	3-33
Slats Failure	3-38
Air Intake Cowl Failure	3-38
Probe Heater Failure	3-39
Airbrake Failure	3-39
Baro Set Failure	3-39
Datum Adjust/Trim Failure	3-40
Low Speed Recovery	3-40
Autothrottle Failure	3-41
AVIONIC SYSTEM FAILURES	3-41
Radar Shut Down/Total Failure	3-41
Inertial Navigation Failure	3-42
Radar Altimeter Failure	3-42
Navigation Computer Failure	3-42
TACAN Failure	3-43
Attack Computer Failure	3-43
Single/Double CIU Failure	3-43
Double Rear CIU Failure	3-44
Single/Double CSG Failure	3-44
Double CSG/CIU Failure	3-45
GPS Failure	3-46
Monitor Trip	3-46
IFF Interrogator Overtemperature	3-47
IFF Warnings/Failures	3-47
GPWS Failure	3-47
DASS Computer Failure	3-48
Flare Dispenser Failure	3-49
Chaff Dispenser Failure	3-49
ECS FAILURES	3-49
ECS Failure	3-49
ECS Fan Failure	3-50
Cabin Low Pressure	3-50
Cabin High Pressure	3-51
Hot Bleed Air Leak	3-51
Smoke or Fumes in Cockpit	3-52
Oxygen Failures	3-52
UCS Front Computer Failure	3-53
Windscreen Heater Failure	3-53

AER(EP).1F-EF2000(T)-1
Canopy not Locked 3-53
SINGLE ENGINE OPERATIONS..... 3-53
Single Engine Operation 3-53
ECS/SPS Compatibility Area 3-54
APPROACH AND LANDING EMERGENCIES3-56
Engine Failure On Approach..... 3-56
Nose Wheel Steering Failure Approach / Landing 3-56
NWS Failure-Pre Take-off/Landing... 3-57
Brakes Failure..... 3-58
Anti-Skid Failure..... 3-58
Hook Down..... 3-58
Cable Engagement - Departure End. 3-59
Cable Engagement - Approach End . 3-59
LANDING GEAR FAILURES..... 3-60
Landing Gear Retraction Failure..... 3-60
Landing Gear Fails to Lower..... 3-61
Landing with Gear Unsafe..... 3-61
Landing Gear Collapsing..... 3-63
Landing with a Known Blown Tire..... 3-63
Brake Chute Loss of Function..... 3-63
ARMAMENT SYSTEM FAILURES 3-63
ACS Failure..... 3-63
SCAC Failure 3-63
NSCAC Failure..... 3-64
DU Failure 3-64
EJ Failure 3-64
SJ Failure 3-64
Gun Failure 3-64
Gun Scoop Failure 3-64

ADVICE

Advice

(1B-B-15-41-01-00A-141A-A Issue 003)

Introduction

The following emergency procedures must be followed in response to an emergency condition. These emergency procedures will ensure the maximum safety for the aircrew and/or the aircraft until a safe landing or other appropriate action is accomplished. The most important consideration in all emergencies is to continue flying the aircraft safely. All emergencies must be dealt with as follows:

1 Fly the aircraft
2 Identify the emergency
3 Carry out the Boldface procedure
4 Carry out the subsequent procedure.

NOTE

All emergency procedures contained in the Flight Crew Checklist (FCC) are presented in this format, i.e. Indications, followed by a boldface action (if required), followed by any subsequent action(s).

The procedures are arranged in the most desirable sequence for the majority of emergencies. All actions must be performed in the listed sequence, unless the aircrew can determine a good reason for any deviation. Multiple failures, adverse weather and other abnormal conditions may require modification of these procedures.

The nature and severity of the encountered emergency will dictate the necessity for complying with the critical items in their entirety. It is therefore essential that the aircrew determine the correct course of action by using airmanship and sound judgement.

Identifying an Emergency

It is essential that any emergency is quickly and correctly identified using the visual and audio warnings available. Visual warnings are presented via the attention getters and the Dedicated Warning Panel (DWP).

The pilot can immediately identify technical failures from the audio (voice warnings and attensons) and visual (attention getters and DWP captions) warnings. Further information is available on the MHDD Warnings format.

Some emergencies require an immediate pilot response as soon as practicable after identification of the emergency and before selection/carrying out of the full checklist actions. These are known as Boldface Actions and must be memorized by the pilot.

Subsequent Procedures

Having carried out any boldface actions, the pilot must select the MHDD Warning format for the emergency that was identified, confirm the diagnosis using the warning format and other displays and then carry out the remaining emergency procedures by following checklist actions.

Categories of Warnings

Warnings can be generated both by system failures (technical failures) and by procedural failures, for example, exceeding a speed limit or failing to make a switch selection required to carry out a normal action. Since some Warnings require immediate pilot response, while others are just advising the pilot of something less critical or urgent, the Warnings are defined in five seperate categories. Starting with the most critical category, the Warnings are as follows:

Catastrophic Warnings

A Catastrophic Warning is an event that makes it impossible for the aircraft to continue safe flight and handling. Immediate action is required by the aircrew which may, under certain circumstances, involve immediate ejection.

Category 1 Warnings

A Category 1 Warning is of a procedural nature, eg low height warning, and warns of a situation that requires immediate action.

Category 2 Warnings

A Category 2 Warning is related to a system technical failure that requires immediate action.

Category 3 Warnings

A Category 3 Warning is related to a system technical failure that requires attention.

Category 4 Warnings

A Category 4 Warning is procedural only and provides advice or information of a procedural nature.

Land As Soon As Possible

Land As Soon As Possible (Land ASAP) is defined as a landing that should be accomplished at the nearest suitable airfield, considering:

- The severity of the emergency
- Weather conditions
- Landing facilities
- Ambient lighting
- Aircraft gross weight.

Land As Soon As Practicable

Land As Soon As Practicable is defined as an emergency condition, but of a lesser urgency than Land ASAP. Although the mission must be terminated, the degree of the emergency is such that the immediate landing at the nearest suitable airfield may not be necessary.

GROUND EMERGENCIES

Ladder not Locked

(1B-B-15-42-06-00A-141A-A Issue 003)

Description

LADDER

The majority of ladder unlocked warnings will be as a result of incorrect ladder stowage and door closure on the ground. In these cases the aircrew should instruct the ground crew to check that the ladder is correctly stowed and the door is correctly pushed into the closed/locked position.

If the ladder unlocked warning is generated in flight it is more likely to be spurious, but as a precautionary measure the left engine should be selected to IDLE and the aircraft landed ASAP.

Procedure

If ladder detected not locked in flight:

1. Speed ..... Minimum practicable
2. Left throttle ..... IDLE, if practicable
3. Land ..... As soon as practicable

ABANDONING

Emergency Ground Egress

(1B-B-15-42-02-00A-141A-A Issue 005)

Description

The pilot must decide whether to abandon the aircraft through manual egress or ejection. The decision will depend upon the type and severity of the emergency situation and the condition/position of the canopy.

If ejection is necessary the crew should confirm, with each other, the course of action.

If ejection is not necessary, the aircrew should egress the aircraft as quickly as possible by:

– Holding the Aircrew Services Package (ASP) man portion manual release handle, pressing the locking lever and rotating the handle upwards
– Move the Safe/Armed/Egress handle to the EGRESS position to release the Liquid Suit Connector Assembly (LSCA) man portion and Personal Services Package (PSP) lowering line arrowhead connector
– Press the faceplate release button and rotate as far as possible until it unlocks to release the Quick Release Fitting (QRF) on the shoulder straps and arm restraint line lugs.

Procedure

If ejection is necessary:

1. Eject

If ejection is not necessary:

1. **Throttles.....HP SHUT**
2. **ASP.....Man portion release**
3. **Seat safety lever.....EGRESS**
4. **QR F.....Unlock/Release**
5. **Canopy.....Open/Jettison**
6. **Ladder.....Deploy**

Ejection

(1B-B-15-42-03-00A-141A-A Issue 005)

Description

The escape system is cleared from zero to 600KCAS or M2.0, whichever is the lower and from 0-55 000ft.

Pre-Ejection

Where the CMS is set to FRONT and the front seat crew member is unable to initiate ejection, the rear seat occupant should change the CMS, located on the right hand console, to BOTH to facilitate escape. For Command Mode Selector operation see Ejection Sequence pag. 1-286.

NOTE

Before initiating ejection alert the other crew member if time permits.

Lower visor, sit erect, close eyes tightly, and perform the following:

– Grasp the seat firing handle with both hands, stretch out legs, maintain upright posture with head pressed against the headpad.
– Pull the handle firmly upwards, to its full extent, and hold until the harness retraction mechanism functions.
– If the Seat fails to eject, immediately pull the firing handle again. If the handle will not move, make sure that the safety pin has been removed and that the SAFE/ARMED handle is set to the ARMED position before making any further attempts.

Abandoning

To eject normally, complete as much of Para as time and conditions permit. In flight, the optimum speed for ejection is 180 to 230KDAS. Where possible, to avoid excessive loading on the parachute, initiate ejection below barostat height.

Ejection at Medium/High Level

At altitude, aircraft attitude is not important, but in controlled conditions adjust speed and height before ejection. Ideally, position the aircraft over an unpopulated area. If possible set the aileron trim at one half in either direction and the throttle lever at IDLE before ejection; the aircraft should then impact within a short radius of the ejection point.

Do not delay ejection if the aircraft is in a descent from which it cannot be recovered. If recovery from an unusual attitude or departure from controlled flight has not been achieved or imminent by 5000ft AGL, eject. If the aircraft is out of control at high IAS, eject above 8000ft if possible.

Ejection at Low Level

At low altitude, the aircraft should be in level flight to provide optimum ejection conditions. Successful ejection at low level requires initiation within the limitations of dive angle, bank angle, airspeed and terrain clearances. Where circumstances permit, gaining altitude will improve escape conditions.

AER(EP).1F-EF2000(T)-1

The crew must make the final decision as to the minimum safe height from which an ejection can be made in the prevailing conditions, but every effort must be made to initiate ejection while the aircraft is well above the minimum height.

Procedure

If time and conditions permit:

1. Conditions..... Nominal straight and level
   180 to 230KDAS
   9000ft (ideal)
2. Heading ..... Towards unpopulated area
3. XPDR..... EMGY
4. Harness ..... Locked
5. Oxygen mask..... Tight
6. Visor ..... Down
7. Radio ..... Call
8. Throttles..... IDLE
9. Assume ejection position
10. Eject

TAKE OFF EMERGENCIES

Abort

(1B-B-15-43-01-00A-141A-A Issue 006)

Description

The situation and conditions will dictate the required pilot actions to successfully accomplish an abort. The basic abort procedure takes care of all abort situations, e.g. all types of system failures which may lead to an abort and the more critical engine failure.

The decision to abort or to continue takeoff at the time of failure will mainly depend on speed, aircraft mass, remaining runway length and condition, weather and arresting cable availability.

Most operations are performed from an established base with at least a standard NATO runway and a known standard cable available. Take off data for operations from shorter runways, especially at higher weights and temperatures must be carefully considered with reference to the performance data set.

WARNING

- UNLESS THE EMERGENCY DICTATES, DO NOT APPLY BRAKES ABOVE THE MAXIMUM BRAKE-ON SPEED (MBS) AS DEFINED IN THE MAXIMUM BRAKE-ON SPEED CHART.
- DO NOT APPLY BRAKES WITH THE NOSEWHEEL OFF THE GROUND.

Full brake pedal deflections including stepped pedal inputs may be used to achieve maximum braking which will decelerate the aircraft sufficiently to be in the envelope of the respective cable.

Maximum deployment speed for the brake chute is 175 KDAS.

Lift Dump will be automatically activated if the requirements are fulfilled, i.e. both throttles at IDLE position and NW on the ground.

If aborting, select both throttles to IDLE, deploy the brake chute and apply full forward stick until wheel braking is initiated (below MBS). After positive brake application, aft stick may be applied to assist braking action, otherwise return the stick to neutral.

1. **Throttles .....IDLE**
2. **Brake chute .....Deploy**
3. **HOOK .....As required**
4. **Brakes .....Apply as required**

BRAKING

For Maximum Brake-On Speeds (MBS) refer to .

For an abort outside the given clearance, deceleration to full stop is only possible with chute deployment prior wheel braking and/or arrestor cable engagement. Once the brake energy has been absorbed, loss of brake capability together with possible asymmetric control behavior has to be expected.

Pedal application to full deflection is possible. At speeds less than 9 kts smooth pedal inputs shall be applied (anti-skid drop-out speed).

CABLE AVAILABLE/ENGAGEMENT ANTICIPATED

The arrestor hook engagement speed for an abort is dependent on the airfield used barrier type. For more information on arrester hook engagements, refer to .

To ensure successful cable engagement, the hook must be released not later than 3 sec. or 200 m prior

to arresting. 1000 ft in front of the cable (runway foot marker) should be used as a guideline.

The brakes must be released 2-3 seconds prior arresting, to ensure that the aircraft is in an un-braked steady condition. Engines at idle.

Cable engagement is cleared with NWS engaged or disengaged.

When the aircraft has stopped, it may be pulled back. To prevent any possible tip-over, brakes should not be used to counteract the roll-back or to correct slight deviation during roll-back. Instead, engine thrust should be used to control the pullback.

NO CABLE AVAILABLE/ENGAGEMENT NOT ANTICIPATED

When a cable is not available or if aborting at an early stage during the take-off roll, retard both throttles to IDLE, deploy the brake chute, apply full forward stick until brakes are applied below MBS. If aborting at a late stage, i.e. during rotation, it is recommended to assist the de-rotation by applying half forward stick. For all cases where no cable is available at the departure-end, maximum braking can be applied earliest when the aircraft has decelerated to the recommended MBS which can be obtained from the MBS chart.

Tire Failure During Take-off

(1B-B-15-43-05-00A-141A-A Issue 006)

In the case of a tire failure, either nose- or mainwheel, abort whenever possible. If take-off is continued do not retract the landing gear to avoid damage to the gear and/or to the gear doors.

If aborting with a main tire blown, directional control may be difficult. Therefore, it is important to hold the NW firmly on the ground.

If not aborting:

1. **Landing Gear.....Do not retract**
2. Land .....As soon as practicable, refer to Landing with a Known Blown Tire pag. 3-63.

Engine Failure During Take-Off

(1B-B-15-43-02-00A-141A-A Issue 005)

If an engine failure occurs before reaching the minimum go speed, the take-off must be aborted, because the thrust available is insufficient to accelerate the aircraft to take-off speed within the remaining runway.

If an engine failure occurs beyond minimum go speed and before refusal speed, the take-off can either be aborted or continued.

However, once refusal speed is reached, takeoff must be continued since the aircraft cannot be stopped either within the remaining length of the runway, or the remaining runway distance to cable, considering the maximum engagement speed for the cable.

If take-off is continued with partial or total loss of one engine, speed must be the same as with two engines in order to meet the performance data requirements and rotation rate has to be adapted consequently.

Once rotation has commenced, the rotation rate must be maintained until lift-off occurs, but must not exceed 13° to 15°AOA, depending on type of takeoff.

When safely airborne, consider, if possible, landing gear retraction, as single engine climb performance is improved as soon as the landing gear is in transit.

There after, the AOA must be progressively decreased and the aircraft accelerated in a shallow climb.

If required consider external stores jettison.

NOTE

Following external stores jettison, the aircraft will automatically reconfigure. However, if required, the aircraft may be manually reconfigured by pressing the relevant CONFIG selector/indicator.

Select the throttle of the affected engine to HP SHUT and land ASAP.

If decision to stop is made:

1. ABORT

When aircraft stopped:

2. Throttle affected engine ..... HP SHUT
3. LP COCK affected side..... SHUT

If takeoff is continued:

1. **Throttles..... MAX RHT**

When airborne and gear up:

2. External stores ..... Jettison, if required
3. Throttle affected engine ..... HP SHUT
4. LP COCK affected side..... SHUT
5. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

AER(EP).1F-EF2000(T)-1

Reheat Failure During Take-Off

(1B-B-15-43-03-00A-141A-A Issue 008)

L RHEAT or **R RHEAT**

When a reheat failure occurs the appropriate warning is given on the DWP, accompanied by the “Left Reheat” or “Right Reheat” voice warning.
If an engine reheat failure occurs during this phase, the take-off may be either aborted or continued.
If take-off is continued with partial or total loss of one engine, rotation rate and speed must be the same as with two engines in order to meet the performance data requirements.
Once rotation has commenced, the rotation rate must be maintained until lift off occurs, but must not exceed 13° to 15°AOA, depending on type of takeoff.
During take-off, if required, consider external stores jettison.

NOTE

Following external stores jettison, the aircraft will automatically reconfigure. However, if required, the aircraft may be manually reconfigurated by pressing the relevant CONFIG selector/indicator.

When safely airborne retard the throttle of the affected engine into the dry range; reselection of reheat is not permitted.

If decision to stop is made:

1. ABORT

If take-off is continued:

1. Throttles ..... MAX RHT

When airborne and gear up:

2. External stores..... Jettison, if required
3. Throttle affected engine..... DRY range

Engine Performance

(1B-B-15-43-04-00A-141A-A Issue 004)

Engine Performance

L ENG P or **R ENG P**

On ground only

The ENG P reflects the following engine malfunction(s):

– NH/NL mismatching
– NL min, at max fuel flow, less than scheduled
– DECU loss of control (DECU warning caption also displayed)

The resulting effect is that achievable dry thrust for take-off is reduced.

If decision to stop is made:

1. ABORT

If takeoff is continued:

1. Throttles ..... MAX RHT

When safely airborne:

2. Throttle affected engine..... IDLE
3. Land..... As soon as practicable

FIRES

APU Fire on Ground

(1B-B-15-42-04-00A-141A-A Issue 004)

APU Fire On Ground

APU FIRE or CANOPY HORN MODULATED AUDIO WARNING

The APUCU shuts down the APU as soon as a fire or overheat condition (above 260°C) is detected by the APU fire detector.
The fire condition is indicated by the APU FIRE warning on the DWP, flashing attention getters and is accompanied by the voice warning "APU FIRE".
During APU start up the DWP is deactivated; therefore, an APU bay fire warning is provided by the canopy horn audio warning only.
The warning is modulated to prevent it from being confused with the normal canopy operation warning.

1. APU ..... STOP
2. Egress

Engine Fire on Ground

(1B-B-15-42-05-00A-141A-A Issue 008)

L FIRE or **R FIRE**

F button lit

AER(EP).1F-EF2000(T)-1

When a fire is detected in the left or right engine bay, the appropriate warning is given on the MHDD/ENG format and on the DWP. The relevant “F” fire indicator illuminates, the attention getters flash and the “Left Engine Fire” or “Right Engine Fire” voice warning is given.

If a fire occurs in the rear fuselage, damage to the wiring looms can cause the following sustained or intermittent indications:

– TBT, NL, NH
– nozzle (Aj)
– engine control warnings (L/R DECU on MHDD/ DWP)
– all engine related warnings.

Shut down both engines then press the relevant “F” button.

The “F” button provides a one-shot attempt and completely discharges the fire extinguishing agent into the selected bay.

F button lit

1. **L & R throttles .....HP SHUT**
2. **L & R LP COCKs.....SHUT**
3. **Lit F button .....Press**
4. APU.....STOP if running
5. BATT.....OFF
6. Egress

Engine Fire during Take-Off

(1B-B-15-43-07-00A-141A-A Issue 008)

L FIRE or **R FIRE**

F button lit

When a fire is detected in the left or right engine bay, the appropriate warnings is given on the MHDD/ENG format and on the DWP. The “F” fire indicator illuminates, the attention getters flash and the "L Engine Fire" or "R Engine Fire" voice warning is given.

If decision is made to stop, abort.

However, once refusal speed has been reached, take-off must be continued since the aircraft cannot be stopped in the remaining runway length.

If take-off is continued with partial or total loss of one engine, rotation rate and speed must be the same as for two engines. Once rotation has commenced, rotation rate must be maintained until lift-off, but must not exceed 13° to 15° AOA.

During take-off, if required, consider jettisoning external stores.

NOTE

Following external stores jettison, the aircraft will automatically re-configure. However, the aircraft may be manually re-configured by pressing the relevant CONFIG selector/indicator, if required.

When safely airborne, with a positive rate of climb, retract the landing gear to improve single engine climb performance.

Set the throttle of the affected engine to HP SHUT and the LP COCK switch to shut and press the relevant “F” button.

NOTE

When the fire extinguisher bottle has been discharged and the relevant “F” caption extinguishes, it can be assumed that the fire has been extinguished.

The “F” button provides a one-shot attempt, and completely discharge the fire extinguishing agent into the selected bay.

Check for further indications of fire, and if fire is confirmed, eject.

If fire is not confirmed, land ASAP.

Following shutdown of the affected engine, cross-bleed operation starts automatically. Cross-bleed monitoring is indicated by “L/RXBLEED” on MHDD/ PA format.

If fire occurs in the rear fuselage, damage to the wiring looms can provide the following sustained or intermittent indications:

– TBT, NL, NH
– nozzle (Aj)
– engine control warnings (L/R DECU on MHDD/ DWP)
– all engine related warnings.

F button lit

If decision to stop is made:

1. ABORT

When stopped:

2. **L & R throttles..... HP SHUT**
3. **L & R LP COCKs..... SHUT**
4. **Lit F button..... Press**
5. BATT ..... OFF
6. Egress

If takeoff is continued:

1. **Throttles..... MAX RHT**

AER(EP).1F-EF2000(T)-1

When airborne and gear up:

2. External stores..... Jettison, if required
3. Throttle affected engine..... HP SHUT
4. LP COCK affected side..... SHUT
5. Lit F button..... Press
6. Check for further indications of fire.

If fire is confirmed:

7. EJECT

If fire is not confirmed:

7. Land..... ASAP, refer to Single Engine Operation pag. 3-54

Engine Fire in Flight

(1B-B-15-45-01-00A-141A-A Issue 007)

L FIRE or **R FIRE**

F button Lit

When a fire is detected in the L/R engine bay, the appropriate warning is given on the DWP. The F button indicator illuminates, the attention getters flash and a voice warning "Left Engine Fire"or "Right Engine Fire" is given.
Immediately shut down the affected engine and operate the related F button.
Check for further indications of fire and if confirmed, eject. If fire is not confirmed, land ASAP.
When the fire extinguisher bottle has been discharged and the warning light goes off, it can be assumed that the fire is extinguished.
If a fire occurs in the rear fuselage, damage to the wiring looms can provide the following sustained or intermittent indications:

– TBT, NL, NH
– nozzle (Aj)
– engine control warnings (L/R DECU on MHDD/ DWP)
– all engine related warnings.

NOTE

The throttle of the good engine must be set above 65% NL in case of cross-bleed operation with the hydraulic pump failed on good side.

1. **Throttle affected engine..... HP SHUT**
2. **LP COCK affected side..... SHUT**
3. **Lit Fire button..... Press**
4. Check for further indications of fire.

If fire is confirmed:

5. EJECT

If fire is not confirmed:

5. Land..... ASAP, refer to Single Engine Operation pag. 3-54

FLAMEOUT/RELIGHT

Double Engine Flame-out

(1B-B-15-45-02-00A-141A-A Issue 008)

If both engine flameout, they should automatically relight without any pilot action.
In case of auto-relight fails, the DWP enters in GUH mode and the following engine captions will illuminate:

AC GUH

REV ENV

NOTE

L FLAME and R FLAME are triggered if an engine flame-out is detected by the DECU, and the autorelight fails to restart the engine within 5 seconds. If in the mean time the AC is lost, these warnings will not appear as they are not GUH warnings.

Relight engines throughout the Service Flight Envelope. However, the likelihood of successful relight diminished outside the relight boundaries, refer to Section 5.

If **HYD TOT** *lit or critical aircraft operation occurs:*

1. EJECT

If no engine response and failure to autorelight suspected:

1. **Speed..... Rapidly obtain 0.9 M**
2. **Controls..... Minimize / gentle movements**
3. **Throttles..... HP SHUT, in turn**

AER(EP).1F-EF2000(T)-1

4. **Throttles.....Reselect MAX DRY, in turn**
5. **Height.....Reduce to below 28 000 ft**

NOTE

- Best relight envelope is above 0.83 M, altitude below 28 000 ft.
- Relight may take greater than 30 seconds.

Single Engine Flameout

(1B-B-15-45-03-00A-141A-A Issue 008)

L FLAME or **R FLAME**

L OIL P or **R OIL P**

ECS If outside the ECS compatibility area.

The assisted relight and the windmill relight are provided to restart a failed or shut down engine.

CAUTION

A RELIGHT MUST NOT BE ATTEMPTED IF ANY ENGINE MECHANICAL FAILURE HAS OCCURRED.

The windmill relight is the normal engine relight procedure in flight when automatic restart fails. The automatic restart initiates under DECU controls. Windmill relight should be initiated whenever the minimum required NH and altitude can be reached, refer to Section 5

The assisted relight constitutes the method of starting an engine in flight when the windmill relight is unsuccessful or if flying under low altitude and low airspeed conditions so that windmill relight is not practicable.

Following a flameout, the airdrive crossbleed is automatically initiated assuring that both gearboxes remain serviceable.

If automatic restart fails, the throttle of affected engine must be selected to HP SHUT then IDLE or above.

If the aircraft is operated outside the compatibility area the ECS is shut and RAM AIR must be selected, or the aircraft must be recovered into the ECS compatibility area.

CAUTION

TBT SHOULD BE MONITORED DURING RELIGHT BECAUSE IT IS NOT AUTOMATICALLY CONTROLLED BY THE DECU. RELIGHT IS TO BE ABORTED IF TBT EXCEEDS 750°C.

NOTE

During an assisted relight in flight the following warning captions could temporarily appear on DWP:

– **L GEN** / **R GEN** OR

– **L CONT P** / **R CONT P** / **L UTIL P** OR **R UTIL P** OR

– **L COWL** / **L COWL** OR

.

Observe a slow initial rise in NH and TBT, followed by an engine wind-up to IDLE rpm. When the engine is at idle, the caption OIL P is occulted.

If restart is not obtained or TBT is likely to exceed 750°C before NH reach IDLE rpm, shut down the engine and attempt further relight at lower altitude/ higher airspeed.

CAUTION

IF A GEARBOX FAILURE OR GEARBOX UNDERSPEED IS INDICATED REFER TO GEARBOX FAILURE (INCL. SERVICES LOST) PAG. 3-25.

If the relight is unsuccessful, consider an assisted relight.

If no auto-relight:

1. **Throttle good engine..... DRY range**
2. Affected engine ..... Check NH above 5%
3. Throttle affected engine ..... HP SHUT, then IDLE or above

AER(EP).1F-EF2000(T)-1

If relight not successful:

4. Carry out further attempts at lower altitude / higher airspeed or consider an Assisted Relight Assisted Relight pag. 3-11

If TBT exceeds 750°C:

5. Throttle affected engine ..... HP SHUT
6. LP COCK affected side ..... SHUT

NOTE

Best relight envelope (unloaded relight) is 0.8 to 0.9 M, altitude below 26 000 ft.

7. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

Assisted Relight

(1B-B-15-45-04-00A-141A-A Issue 008)

CAUTION

A RELIGHT MUST NOT BE ATTEMPTED IF ANY ENGINE MECHANICAL FAILURE HAS OCCURRED

The assisted relight is the starting engine method, in case of unsuccessful windmill relight in flight and particularly under low altitude/airspeed conditions, refer to for assisted relight envelope.

As soon as the assisted relight is requested, the operating cross-bleed is stopped to synchronize the AMAD gearbox speed and engine windmilling speed, then the AMAD gearbox dog clutch is automatically closed to drive the engine up to idle speed in ATS/M driven mode.

Because of the assisted relight procedure requests to stop the operating cross-bleed, it is mandatory to check the windmilling engine speed before to start the assisted relight procedure. In fact, if the hydraulic pump at the donor engine side is failed and the windmilling speed is lower than 50% a total loss of hydraulic power could occur.

The prerequisites for a successful assisted relight are serviceable air cross bleed and gearboxes.

WARNING

DO NOT ATTEMPT ASSISTED RELIGHT IF LIVE ENGINE HYD OR GEN WARNINGS ARE PRESENT. HYD COULD BE LOST DEPENDING ON THE WINDMILLING SPEED OF THE RELIGHTING ENGINE.

1. Throttle good engine .. 65 % NL min
2. Throttle affected engine ..... HP SHUT, then dry range
3. AIRDRIVE ..... EMGY and release

If TBT exceed 750°C:

4. Throttle affected engine ..... HP SHUT
5. LP COCK affected side ..... SHUT
6. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

If **L ATSM** *or* **R ATSM** *is displayed:*

4. Throttle affected engine ..... IDLE
5. Altitude ..... Below 10 000 ft if practicable

ENGINE FAILURES IN FLIGHT

Engine Vibration/Mechanical Failure

(1B-B-15-45-08-00A-141A-A Issue 007)

L VIBR or **R VIBR**

The majority of all known engine failures are accompanied by the corresponding caption(s) on the R MHDD/DWP. Nevertheless in some cases, i.e. mechanical failure, there are no associated warnings. The related mechanical failures can be caused by bearing failures, seizures of rotating parts, blades failures, etc.
Such malfunctions can be accompanied by vibration, engine rundown or seizure, rumbling noises or a loud bang.

AER(EP).1F-EF2000(T)-1

If any of the above mentioned symptoms are present,within 10 seconds of warning activation, retard the throttle of the affected engine to dry range until vibrations disappear. If symptoms are still present, shut down the affected engine.

Engine Vibration / Mechanical Failure

1. Throttle affected engine .....Reduce in dry range until vibration disappears

If warning goes out and vibration no longer persists:

2. Throttle affected engine .....Maintain setting
3. Land .....As soon as practicable

If vibration warning remains and / or mechanical failure is suspected:

2. Throttle affected engine .....HP SHUT
3. LP COCK affected side.....SHUT
4. Land .....ASAP, refer to Single Engine Operation pag. 3-54

Engine Vibration / Icing

L VIBR and / or **R VIBR**

with **ICE**

1. **Throttle affected engine.....Advance by at least 10% NL**

If vibration warning goes out within 10 seconds:

2. Continue normal operation

If vibration warning does not go out within 10 seconds:

2. Throttle affected engine(s) .....Reduce within dry range until vibration disappears

If vibration warning remains and / or a mechanical failure is suspected:

3. Throttle affected engine .....HP SHUT
4. LP COCK affected side.....SHUT
5. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

Engine Oil Pressure Low

(1B-B-15-45-05-00A-141A-A Issue 006)

L OIL P or **R OIL P**

An engine oil pressure low condition is indicated by the appropriate warning on the DWP, accompanied by the “Left oil pressure” or “Right oil pressure” voice warning and the attention getters flashing.
An engine oil low pressure condition can be caused by loss of engine oil, malfunction of the engine oil system or when maintaining the aircraft over a prolonged period at an abnormal attitude.
If the L/R OIL P warning is shown, immediately retard the relevant throttle to IDLE and if at zero or negative "G" conditions restore positive "G" conditions with climb and dive angles less than 30°.
However, if the warning persists for more than 10 seconds after the aircraft has attained level flight, the engine must be shut down to avoid bearing failure or engine seizure.

1. Throttle affected engine ..... IDLE
2. Recover..... Nominal straight and level flight

If warning persists for more than 10 seconds:

3. Throttle affected engine ..... HP SHUT
4. LP COCK affected side..... SHUT
5. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

Engine Oil Overtemperature

(1B-B-15-45-06-00A-141A-A Issue 008)

L OIL T **R OIL T**

An engine oil overtemperature conditions is indicated by the appropriate warning on the DWP, accompanied by the “Left Oil Temperature” or “Right Oil Temperature” voice warning and the attention getters flashing.
An engine oil overtemperature condition can be caused by heat exchangers failure, FCOC failures or bearing overtemperature. If the **L OIL T** or

R OIL T warning is shown, within 10 seconds from warning activation, retard the relevant throttle to IDLE and recover to 1g level flight. However, if the warning persists for more than 5 minutes after the aircraft has attained level flight, the engine must be shut down to avoid bearing failure.

1. Throttle affected engine ..... IDLE
2. Recover ..... Nominal straight and level flight
3. Altitude ..... Below 36 000ft, if possible

If L OIL T or R OIL T warning goes out:

4. Continue normal operations

If warning persists for more than 5 minutes:

4. Throttle affected engine ..... HP SHUT
5. LP COCK affected side ..... SHUT
6. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

NOTE

Engine relight is permitted if required for critical flight condition provided that the L OIL T or R OIL T has gone out.

Engine Surge

(1B-B-15-45-07-00A-141A-A Issue 007)

A surge is an aerodynamic disruption or reversion of airflow through the compressor stages, caused by various reasons such as bird strike, FOD or hot gas ingestion, excessive airflow distortions into the air intake, blade failures, abnormal overfuelling during heavy engine handling, etc.

The typical surge can be expected at high altitude, high AOA, low airspeed and high power demands during engine handling. An engine surge is normally indicated by a rumbling noise, a loud bang or a series of loud bangs accompanied by abnormal engine parameters, TBT increasing rapidly, with stagnation or reduction of NH and/or NL.

Surges at low altitudes are very unlikely and are normally caused by damaged compressor blades.

If the surge self clears, no immediate action is required.

If the surge does not self-clear, reduce the throttle of the affected engine to IDLE. Normally this action will recover the engine from a surge.

If the surge continues (locked-in surge), a phenomenon which is indicated by a light rumble accompanied by stagnation or subidling NH, abnormal TBT at IDLE, reduce AOA and sideslip, descend and increase airspeed if possible.

Should both engines be affected by locked-in surges, shut down the engine with the highest TBT and lowest NH first and then attempt a relight.

1. **Throttle affected engine ..... IDLE**
2. **Recover ..... Nominal straight and level flight**

If surge is locked in:

3. Altitude/Airspeed ..... Descend and/or increase

If surge remains and / or TBT increasing:

4. Throttle affected engine ..... HP SHUT
5. LP COCK affected side ..... SHUT
6. Land ..... ASAP, refer to Single Engine Operation pag. 3-54

NOTE

Engine relight is permitted if required for aircraft critical flight condition provided that no mechanical failure is suspected.

ENGINE CONTROL SYSTEM FAILURES

DECU Failure

(1B-B-15-45-10-00A-141A-A Issue 007)

L DECU or **R DECU**

CAUTION

SIMULTANEOUS DECU WARNINGS ON THE MHDD/ENG FORMAT AND DWP INDICATE THAT THE DECU IS UNABLE TO MAINTAIN FULL DRY ENGINE CONTROL, AND IS OPERATING IN A DEGRADED MODE DUE TO FAILURES ON EACH OF THE TWO LANES OF THE DECU.

The warning indicates that the engine control is lost of the affected side. The engine automatically

AER(EP).1F-EF2000(T)-1

stabilizes near idle with no throttle response. Engine indications on MHDD may be unreliable. The engine speed will vary with flight conditions. At lower pressure conditions, this will provide higher thrust levels than at SLS, where the minimum mechanical fuel flow stop represents slightly lower thrust than idle. At high altitude, with the engine running down after a failure, there is a greater risk of surge.

If no other engine malfunctions, engine is automatically stabilized near flight idle.

1. Land .....As soon as practicable

If NL falls below 30%:

1. Throttle affected engine .....HP SHUT
2. LP COCK affected side.....SHUT

CAUTION

THE SHUT-DOWN ENGINE MUST NOT BE RELIT.

3. Land .....ASAP refer to Single Engine Operation pag. 3-54

Engine Control System Failure

(1B-B-15-45-13-00A-141A-A Issue 006)

If corrupted data is being used for engine control and transmitted from the aircraft to the DECU, automatically the DECU will reduce and latch to flight idle the affected engine. When the FCS data reverts to correct data, the DECU will unlatch the system. There will be not indication of this condition to the pilot because there may be no cockpit indications of a malfunction.

If a failure occurs in the engine air flow control system, causing a loss of pressure, control of the nozzle and VIGV position are lost.

There are certain other system failures which may be affect engine performance without cause indications of L/R DECU warning on MHDD/DWP.

The DECU automatically inhibits reheat reselection in the event of hydraulic system (nozzle) failure or reheat flameout, to prevent potential damage to the reheat system.

When a failure occurs within the engine control system no system warning will be indicated. The following characteristics can be noted:

– inconsistency between AJ/NH
– limited dry modulation
– L/R RHEAT warning
– slow or no response in reheat
– thrust reduction

No pilot action is necessary. Be carefull of possible further engine malfunctions.

Reheat Failure

(1B-B-15-45-11-00A-141A-A Issue 006)

L RHEAT or **R RHEAT**

If REHEAT is selected and does not light up or flames out, this will be indicated in the cockpit by the L/R RHEAT amber warning on the MHDD and DWP. This warning will occur when the throttle is in the reheat range.

A reheat emergency shut-down will be initiated if a “not-lit” signal is detected by the DECU.

The reheat selected but not lit indication will extinguish when the throttle is retracted to the engine dry range.

The reheat sequence arming speed during an acceleration is NH = 85%.

A reheat emergency shut-down will be initiated if NH falls below the reheat cancellation (disarming) speed, NH = 80%, while reheat is operating or reheat being selected.

Reheat re-selection may be attempted throughout the flight envelope, but will be automatically inhibited by the DECU if the warning was initiated by an hydraulic failure within the area of the operating envelope below boundary line “B - B” (see fig. Figure 3.1). The DECU may also automatically inhibit reheat operation following a warning initiated by any other cause within the area of the flight envelope below boundary line “C - C” (see fig. Figure 3.1). This is to prevent potential damage to the reheat system.

AER(EP).1F-EF2000(T)-1

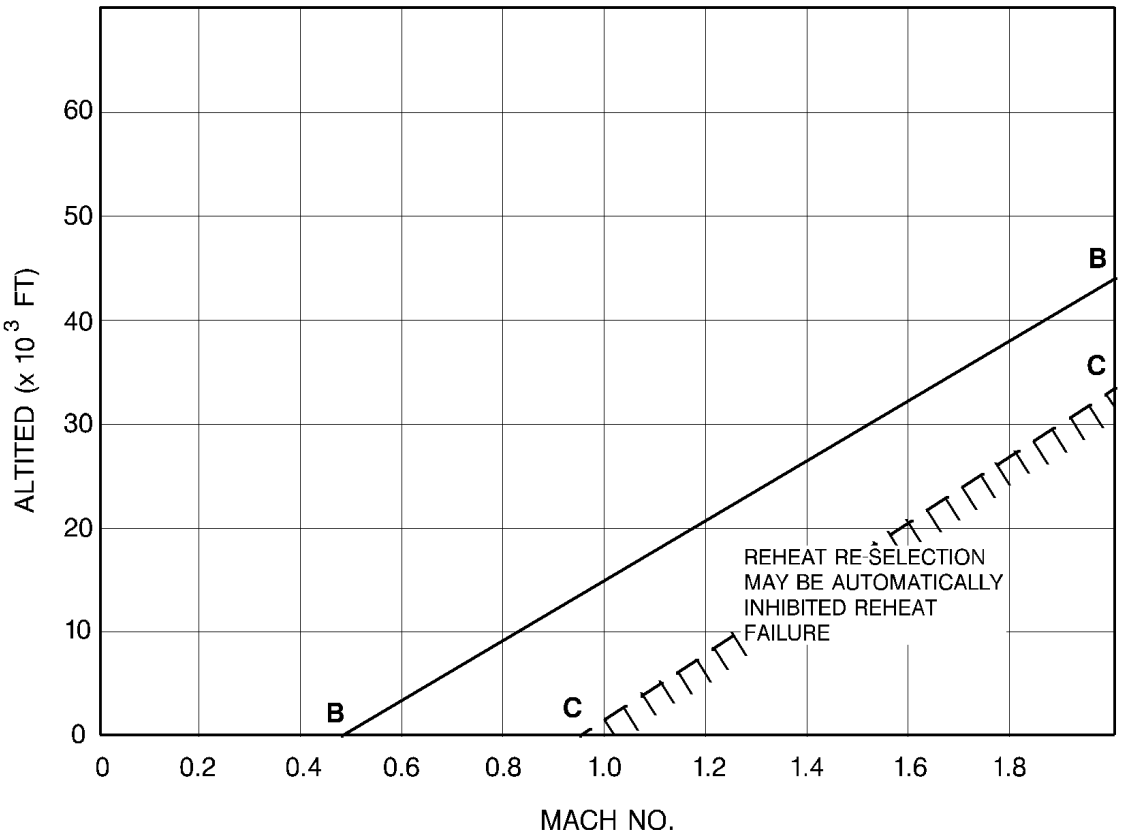


Figure 3.1 - Reheat re-selection boundary

AER(EP).1F-EF2000(T)-1

1. Throttle affected engine .....Dry range, smooth and progressive movements

NOTE

If warning extinguished the reheat re-selection is permitted.

SPS Computer Failure

(1B-B-15-44-12-00A-141A-A Issue 005)

L SPS C or **R SPS C**

When a left or right SPS computer failure is detected, the appropriate warning is given on the DWP. The attention getters flash and the "left SPS computer" or "right SPS computer" voice warning is given.

When the left or right SPS computer fails the following services for the affected side will be lost:

- Assisted engine relight / start
- Cross bleed operation
- Monitoring and capability to generate the following warnings relevant to the SPS: L/R POT, L/R GBOX, L/R GBOX T, L/R ATSM (DWP normal mode) and, for the left SPS computer failure only, SPS P
- Monitoring and capability to generate the following warnings relevant to the hydraulic system: L/R CONT P (DWP normal mode), L/R UTIL P, L/R HYD T, L/R HYD A (on ground only), plus MHDD/HYD format and SKs functions
- Ice detection system will be lost after left SPS computer failure
- APU FIRE warning on DWP (normal mode only) and the respective aural warning will be lost after left SPS computer failure
- L/R FIRE warning on DWP (normal mode only), respective aural warning and L/R FIRE warning on MHDD/ENG format will be lost after the respective (L or R) SPS computer failure.

1. Land ..... As soon as practicable

SERVICES / WARNING LOST					
Assisted relight/engine start					
Cross bleed (affected engine)					
MHDD / HYD format and SK functions					
SPS warnings:					
L POT	**R POT**	**L GBOX T**	**L GBOX**	**R GBOX**	**L ATSM**
R GBOX T			**R ATSM**		
HYD warnings:					
L CONT P	**R CONT P**	(DWP normal mode only)			
L UTIL P	**R UTIL P**	**L HYD T**	**R HYD T**		
Fire warnings:					
L FIRE	**R FIRE**	(DWP normal mode only)			
		(MHDD/ENG format fire warnings)			
		(Aural warning)			
APU FIRE		(DWP normal mode only)			
ICE		(L SPS C only)			

AER(EP).1F-EF2000(T)-1

SPS Air Leak

(1B-B-15-44-13-00A-141A-A Issue 007)

SPS LEAK

An SPS piping air leak condition is indicated by the appropriate warning on the DWP, accompanied by the “SPS leak” voice warning.
To minimize the hot air flow, the pilot has to set the engine throttles at minimum possible.
If the cross-bleed is operating, in order to remove the leakage in the SPS piping set the AIR DRIVE switch to OFF position then land as soon as practicable. During single engine operation it is recommended not to set the AIR DRIVE switch to OFF if on good engine side the relevant GEN and/or CONT P warnings are lit.

Two engines operation:

1. Throttles..... Minimum practicable
2. Land..... ASAP

Single engine operation:

WARNING

IF GEN OR CONT P LIT ON GOOD ENGINE DO NOT SELECT AIRDRIVE TO OFF.

1. Throttles..... Minimum practicable
2. AIRDRIVE..... OFF
3. Land..... ASAP refer to Single Hydraulic Failure pag. 3-30

FUEL SYSTEM FAILURES

Fuel Supply Low Pressure

(1B-B-15-44-01-00A-141A-A Issue 006)

Description

L FUEL P or **R FUEL P**

Low fuel pressure, e.g., double boost pump failure in one or both group tanks, is indicated by a L FUEL P and/or R FUEL P Cat 3 warning with associated attention getters and voice warning. Since the low pressure may also be associated with the low fuel rates (e.g. following either a leak, the failure of all boost pumps or an over-extended period of negative g flight) it is possible that gearbox cooling will be reduced. If this results in the generation of an associated FUEL T warning, the crossfeed should be left closed so as to minimize the risk of overheating both sides of the fuel system.
In the case of double AC failure, the AC/DC pump will operate in its DC mode. In this mode the pump will adequately feed the right engine and the right recirculation line throughout the dry range. The XFEED should not be opened in this case, as the positive pressure will cause fuel to be used from the rear group only, causing an eventual imbalance. It should be noted that the TANK INTC soft-key is inaccessible under double AC failure conditions.

Procedure

If a fuel leak is suspected then refer to Fuselage Fuel Leak pag. 3-21.

1. Recover ..... Positive g
2. Throttles..... Dry range
3. Altitude..... Below 15 000 ft, if practicable
4. FUEL format ..... Check BOOST PUMP status

If multiple boost pump failure:

WARNING

DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL LEAK AND/ OR FUEL T WARNING.

5. XFEED..... OPEN
6. FUEL format ..... TANK INTC select
7. Land..... ASAP

Low Fuel

(1B-B-15-44-03-00A-141A-A Issue 007)

Description

FUEL LOW

A low fuel warning will occur if the fuel contents in either main group fall below 375 kg. Until the cause is established recover the aircraft to positive g; the throttle associated with the low fuel group should be set to the minimum practical setting, to allow low fuel group replenishment; the fuel cross-feed valve should be closed, until a leak can be discounted; fuel contents, balance and transfer status should be checked.

NOTE

Fuselage group asymmetry, not associated with unequal engine demand or transfer failure, indicates a leak within a group or the associated engine feed line.

Procedure

Maintain the following conditions until group(s) replenish or cause is established:

1. Recover.....Positive g
2. Throttle low group .....Minimum practical
3. Fuel format.....Confirm TANK INTC closed
4. XFEED .....NORM

If fuel leak confirmed:

5. Refer to Fuselage Fuel Leak pag. 3-21.

If fuel is hung-up:

6. Refer to Fuel Transfer Failure pag. 3-18.

If a fuel imbalance is apparent:

7. Refer to Fuel Balancing pag. 3-19.

Fuel Transfer Failure

(1B-B-15-44-04-00A-141A-A Issue 006)

Description

XFER

Upon receipt of a fuel XFER warning the aircraft should be recovered to straight and level flight. Fuel contents and balance must be checked via the FUEL format to establish the problem area. If fuel is hung-up or the automatic sequence has stalled, then it should be advanced using the XFER soft-key. Once flow is restored then a precautionary landing should be considered as the XFER warning may again be triggered. Should the warning exist for any other reason, such as a failed open fuel valve for example , then this may lead to CG movement. Under these circumstances the fuel balancing drill, Fuel Balancing pag. 3-19 should be referred to.

NOTE

The warning may also be generated by dry wing transfer pumps, resulting from sustained lateral g maneuvers.

External fuel transfer may cease as a result of low tank pressurization, due to low throttle settings. This type of transfer failure will not initiate a XFER warning and will not allow the stage to advance.

Procedure

1. Recover..... Nominal straight and level flight
2. FUEL format..... Check contents/ balance

If fuel hung-up or automatic sequence not advancing:

3. FUEL format..... XFER select appropriate stage

If fuel flow to main groups is not restored:

3. Land ..... ASAP

NOTE

If normal fuel flow to main groups is restored and XFER caption extinguishes continue mission.

Otherwise:

3. Fuel ..... Balance, refer to Fuel Balancing pag. 3-19
4. Land ..... As soon as practicable

Fuel Over Temperature

(1B-B-15-44-05-00A-141A-A Issue 006)

Description

L FUEL T or **R FUEL T**

If the fuel temperature becomes >86°C then an amber warning is triggered. If the red warning is triggered, then the affected engine must be shut down. If any combination of consequential gearbox oil temperature, hydraulic temperature and AC generator warnings are triggered, the AIRDRIVE switch must be selected OFF. This is to prevent further damage occurring within the affected gear box and associated services. It also removes the off-take of bleed air from the operating engine.

Procedure

1. L/R BOOST PUMP.... L/R BOOST PUMP
2. Throttle affected engine ..... Increase, if practicable

AER(EP).1F-EF2000(T)-1

3. Altitude ..... Reduce, if possible
4. FUEL format ..... Monitor fuel temp

If **L GBOX T** *or* **R GBOX T** *triggered:*

CAUTION

PROLONGED OPERATION IN THE PRESENCE OF A FUEL T WARNING WILL EVENTUALLY LEAD TO CONSEQUENTIAL GBOX T, HYD T, OIL T AND GEN T WARNINGS. IF CONSEQUENTIAL WARNINGS DO OCCUR, FUEL T HAS PRIORITY.

5. Land ..... ASAP

If **L FUEL T** *or* **R FUEL T** *triggered or* **L OIL T** *or* **R OIL T** *triggered > 5 min :*

5. Throttle affected engine ..... HP SHUT
6. LP COCK, affected side ..... SHUT
7. XFEED ..... NORM
8. Land ..... ASAP, refer to Single Engine Operation Single Engine Operation pag. 3-54

If fuel available to good engine becomes critical:

9. FUEL format ..... TANK INTC select

If associated HYD T and/or GBOX T and/or GEN T warnings occur:

10. AIRDRIVE ..... OFF

NOTE

If FUEL T and/or HYD T / GBOX T / GEN T warnings go out, the engine may be relit for the approach and landing.

Fuel Transfer Valve Failure

(1B-B-15-44-06-00A-141A-A Issue 005)

Description

FUEL VLV

WARNING

HAZARDOUS CG SITUATIONS MAY RESULT FROM PARTIAL SIM REFUELING. IF CG LIMITS ARE EXCEEDED ADHERE TO FCS/ AIRDATA FAILURES PAG. 3-33

If a transfer valve failure has occurred the warning will only be displayed during in-flight refueling. Break contact immediately unless refueling is essential; with a failed refuel valve the aircraft will refuel unequally. Consequently the fuel contents must be monitored closely, to avoid exceeding the CG limit, and tank overflow. Contact must be broken before the affected tank or group indicates full.

Procedure

1. Contact ..... Disconnect

Do not attempt in-flight refueling

Fuel Balancing

(1B-B-15-44-07-00A-141A-A Issue 003)

Description

Fuel contents balancing of the main fuselage groups, can be achieved by several methods, but if a fuel leak is suspected it is vital that both groups are not exposed to it; Fuselage Fuel Leak pag. 3-21 must be referred to as soon as possible. In this case the crossfeed valve must be closed (NORM) immediately. Balancing methods are as follows:

– The tank interconnect valve
– Selective transfer
– Manipulation of boost pumps and crossfeed valve
– Differential engine setting.

If all transferable fuel has been used and main fuselage group fuel only remains, then the tank interconnect valve should be opened, via the MHDD soft-key. This simply allows the contents of the main groups to be equally shared upon opening.

AER(EP).1F-EF2000(T)-1

If fuel contents are to be balanced by selective transfer, the XFER FWD or XFER REAR soft-keys on the FUEL format are used. In the event of a leak or engine failure, selective transfer allows the crew member to move remaining transfer stage fuel to the desired fuselage group in order to correct a front/rear imbalance.

To balance the fuel contents by manipulation of boost pumps and crossfeed valve, the crossfeed (XFEED) valve should be opened. The boost pumps associated with the group with the least fuel should then be selected OFF. This will enable both engines to be supplied from the group containing the most fuel. This method should not be used if the crossfeed valve has failed closed.

The crossfeed valve must not be opened in the presence of a FUEL T warning, as this will allow hot fuel to enter the unaffected group.

Balance may also be restored by differential engine setting; the engine fed by the group with the least fuel should be throttled back to allow the group with the most fuel to be used quicker.

Procedure

WARNING

IF UNEXPLAINED IMBALANCE THEN SUSPECT FUEL LEAK FUSELAGE FUEL LEAK PAG. 3-21 .

1. Recover.....Nominal straight and level flight
2. Throttles .....Dry range

If main group fuel only:

3. FUEL format.....TANK INTC select

Otherwise:

3. FUEL format.....Selective XFER; FWD or REAR

If soft-keys unavailable:

CAUTION

DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL T WARNING.

3. XFEED .....OPEN

If FWD heavy:

4. R BOOST PUMP..... OFF

If REAR heavy:

4. L BOOST PUMP ..... OFF

When balance is correct:

5. L or R BOOST PUMP..... L or R BOOST PUMP
6. XFEED ..... NORM

Fuel Vent Failure

(1B-B-15-44-08-00A-141A-A Issue 005)

Description

VENT

The VENT warning indicates that the fuel tanks are outside their normal operating pressure or temperature limits. The subsequent actions are based on the assumption that an overpressure condition may exist during climb, or an under pressure condition during dive.

Procedure

1. Speed..... 250 to 400 KDAS
2. Load factor ..... Reduce below 5g
3. Throttles ..... Below 80% NL
4. Rate of decent..... Below 6000 ft/min
5. Rate of climb ..... Reduce to zero, if possible

If VENT warning remains:

6. Land ..... As soon as practicable

Fuel Computer Failure

(1B-B-15-44-09-00A-141A-A Issue 005)

Description

L FUEL C or **R FUEL C**

FCS MASS

REV ENV

This warning is accompanied by the FCS MASS warning and the REV ENV warning on the DWP.

AER(EP).1F-EF2000(T)-1

With a single fuel computer failure, one of the effects will be the loss of fuel gauging data from the failed computer. The fuel system will continue to operate with simplex gauging data, however, transfer from external tanks may be lost and internal transfer rates will be degraded due to loss of a transfer pump in each fuel tank. The FCS normally uses the duplex gauging data from the fuel computers for CG calculations but if a fuel computer fails, FCS reverts to an alternative method known as detotalizing. This method of CG calculation is based upon last known valid fuel gauging data, from which, fuel demanded by the DECU is subtracted. The detotalizing algorithm has been written with the assumption that, from the point in time when the failure occurs, all external fuel transfer is automatically suspended, and that internal transfer is initiated and then conducted in the normal sequence. It is possible, in certain circumstances, for a fuel computer failure to occur where external transfer is not automatically suspended. In this case the FCS assumes that the fuel is being transferred from internal transfer tanks, and therefore the estimated CG of the aircraft will be subjected to an increasing error. To minimize this error the aircrew are instructed to manually select the internal transfer stages, via the XFER soft-key, in the correct sequence. It should be noted that on completion of each stage the fuel system will attempt to return to the abandoned external stage(s), therefore it is the responsibility of the aircrew to maintain internal transfer.

Procedure

NOTE

Fuel transfer rates and fuel content displays are degraded. External tank indications may be grossly in error.

1. Recover ..... Nominal straight and level flight
2. Throttles ..... Dry range
3. FUEL format ..... Contents/balance/ stage
4. Land ..... As soon as practicable

If external transfer in progress:

5. FUEL format ..... XFER select STG 1, external fuel no longer available

Fuselage Fuel Leak

(1B-B-15-44-10-00A-141A-A Issue 004)

Description

If a fuel leak is confirmed, transfer should be directed to the good group and the aircraft must be recovered to base as soon as possible, with the throttles set to dry range. Directing fuel to the good group will prevent more fuel entering the affected group.

Procedure

1. Throttles ..... Dry range

NOTE

For wing and external tank fuel leaks no further action is required.

2. FUEL format ..... Confirm TANK INTC closed
3. XFEED ..... NORM
4. FUEL format ..... XFER away from leak

NOTE

In the case of a CG warning the FUEL format will prompt the pilot in the opposite direction to that required.

5. Land ..... ASAP

In-flight Refueling Probe Failure

(1B-B-15-44-02-00A-141A-A Issue 006)

Description

IFR

The IFR warning indicates that the in-flight refueling probe has failed to lock fully in or out when selected. The warning is inhibited for 20 seconds following probe selection, to allow for the normal extension and retraction sequences to repeat.

The FUEL PROBE EMGY OUT selection makes in-flight refueling possible following a left utilities hydraulic failure. When this is selected, the probe will extend fully as normal, but the front door will remain open. Under these conditions the probe should be left out following IFR to ensure the probe and door remains locked.

NOTE

EMGY OUT may be selected when left utilities pressure is good, for example during training. In this case, selecting the probe IN will result in a normal probe retraction.

NOTE

With the probe selected to OUT or EMGY OUT, the automatic fuel transfer sequence is inhibited and the pilot must advance each transfer stage manually.

Procedure

NOTE

The IFR caption may only illuminate 20 seconds after IFR probe selection.

1. Contact.....Disconnect, do not attempt in-flight refueling
2. Probe.....Attempt recycle

NOTE

If FUEL PROBE OUT/EMGY OUT is selected auto transfer is denied. The transfer stage must be advanced using the FUEL format XFER soft-key.

ELECTRICAL SYSTEM FAILURES

Double AC Generator Failure

(1B-B-15-44-20-00A-141A-A Issue 006)

Description

AC

REV ENV

A double AC generator failure is made apparent by the loss of MHDD and the HUD; the DWP fails to REV mode and displays the AC and REV ENV captions. The system will attempt to reset one or both generators automatically, but if this is not successful within 1 second no further attempts will be made. Complete loss of AC functions and the non-essential DC busbars PP1 and PP2 will be evident at this time.

The essential DC busbars PP3 and PP4 continue to be supplied by the DC generators, with PP3 backed by the aircraft battery.

As a consequence of total AC power failure the AC fuel boost pumps will cease to operate and the emergency AC/DC fuel pump will run in its DC mode. Under these conditions the AC/DC pump ensures a supply of pressurized fuel is available in the right engine fuel supply line, to minimize the risk of double engine flameout. It also ensures adequate fuel recirculation for cooling of the right gearbox and associated electrical/hydraulic accessories.

NOTE

The effect of cooling by fuel recirculation can be greatly improved by reducing the right throttle to idle.

The left engine feed line will remain unpressurized, limiting the engine to suction feed only. For this reason the left throttle should be limited to dry range. As a consequence the left gearbox and its associated accessories with begin to overheat, due to the lack of recirculated fuel. As the DWP will be in reversionary mode the aircrew will receive no warning of resultant over temperatures. The left engine and it's associated accessories should not be operated for more than 15 minutes under these conditions.

If landing has not been possible within 15 minutes then the right engine should now be used in the dry range; the left engine should be shut down and the AIRDRIVE should be selected OFF, to avoid further overheating of the left gearbox and its associated accessories. Removing drive from the left gearbox results in the loss of supply to essential busbar PP4, which causes the DC pump to cease operation. As a result only another 15 minutes of operation is available.

NOTE

With loss of supply to PP4 ESS DC will be triggered. Essential busbar PP3 is now the only means of essential supply, backed by the aircraft battery (refer to Essential DC Failure pag. 3-23).

AER(EP).1F-EF2000(T)-1

NOTE

Reducing altitude to <15 000 ft will aid fuel cooling.

Procedure

DWP in GUH mode; cockpit displays blank

If AC warning remains for > 1 second:

1. Throttles..... Right IDLE, left dry range
2. Time..... Note
3. Land..... ASAP, refer to Table , “Services Lost,” on page 3-23 for services lost

After 15 minutes:

4. AIRDRIVE..... OFF
5. Right throttle ..... Dry range

WARNING

FOLLOWING SHUTDOWN OF THE LEFT ENGINE THE RIGHT HYDRAULICS WILL OVERHEAT. CONTINUED SAFE FLIGHT CANNOT BE GUARANTEED BEYOND A FURTHER 15 MIN.

6. Left throttle..... HP SHUT
7. Left LP COCK..... SHUT
8. Land..... Refer to Single Hydraulic Failure pag. 3-30 and Single Engine Operation pag. 3-54

NOTE

Only rear group fuel is available.

Services Lost

TRU 1 & 2	Navigation computer
AC Fuel boost pumps	Attack computer
Avionics cooling fans	CSG 1 / 2
Fuel transfer pumps	CIU 1 / 2
Ice detection	HUD
Probe heating	MHDD L / C / R
Windscreen heating	LINS
Navigation lights	DWP (normal mode)
Brake fans	GPS

Single AC Generator Failure

(1B-B-15-44-21-00A-141A-A Issue 005)

Description

L GEN or **R GEN**

ELEC 1

Under normal operating conditions, AC electrical power is provided by two AC generators. Each generator supplies its own AC busbar, via a generator contactor. If a single AC generator failure occurs the L GEN or R GEN and ELEC 1 warnings are displayed on the Dedicated Warning Panel (DWP). The ELEC 1 warning indicates that some system redundancy is lost. Under these conditions the Bus Tie Contactor No.1 (BTC1) will close, allowing the failed generator to be supplied by the remaining generator.

Procedure

1. Land..... As soon as practicable

Essential DC Failure

(1B-B-15-44-22-00A-141A-A Issue 008)

Description

ESS DC GUH caption only

An ESS DC warning (Cat 2) is indicated when an essential DC busbar fails. During this failure condition fuel transfer will be degraded or disabled;

essential DC services on PP4 or PP3 are lost (immediately in the case of PP4), but services on PP3 are supplied by the battery for a minimum of 5 minutes (the guaranteed life of the battery). Depending on conditions the battery life could be anything up to 20 minutes. The only indication that the battery life has expired is the failure to REV mode of the Dedicated Warning Panel (DWP).

If the DWP failure to REV mode has been preceded by an ELEC 2 caption, then PP3 has failed; the aircraft essential services are now supplied only by PP4. If the DWP fails to REV mode immediately, then PP4 has failed; the services are now supplied by PP3. This is an unfavorable situation as the pilot cannot be sure if PP3 has a generated supply or is being supplied by the battery.

NOTE

The probability of the condition whereby the aircraft is supported by battery power alone, with at least one engine still serviceable, has been assessed and found to be improbable. By far the most likely cause of such an emergency condition is a dual engine flameout.

Procedure

Multiple LRI failure. Loss of generated supply to essential busbar.

NOTE

Fuel transfer will be degraded or disabled.

1. Throttles .....Dry range
2. Land .....ASAP

Electrical Level 2 Failure

(1B-B-15-44-23-00A-141A-A Issue 005)

Description

ELEC 2

ELEC 1

In the event of a left and/or right non-essential DC busbar failure, the ELEC 2 caption is displayed on the DWP, the attention getters flash and a voice message will be heard. Several LRI will fail, but power to both essential DC busbars is maintained. Fuel transfer will be degraded or even denied, so throttles must only be used in the dry range.

Procedure

Multiple LRI failure. Power supply to at least one busbar is lost.

NOTE

Fuel transfer will be degraded or disabled.

1. Throttles ..... Dry range
2. Land ..... ASAP

Electrical Level 1 Failure

(1B-B-15-44-24-00A-141A-A Issue 005)

Description

ELEC 1

Failures may occur within the electrical system which result in the loss of system redundancy but not the loss of any systems functionality, i.e. a further electrical system failure could result in the loss of a busbar, for example, and consequential loss of some aircraft or avionics functionality. These simple failures therefore need no pilot action, since there is no loss of functionality, but it is recommended that the aircraft is landed as soon as practicable, just as a precaution against further electrical system failures.

Procedure

Loss of an LRI, but supply to all busbars is maintained.

1. Land ..... As soon as practicable

NOTE

An ELEC 1 warning is generated if the battery master switch has been selected OFF.

Battery Over Temperature

(1B-B-15-44-25-00A-141A-A Issue 005)

Description

BATT T

A battery over temperature is indicated by a category 3 warning on the DWP. All aircraft systems remain serviceable, however, as a precautionary measure the aircraft should be landed as soon as practicable.

Procedure

1. Land..... As soon as practicable

AC Generator Over Temperature

(1B-B-15-44-26-00A-141A-A Issue 005)

Description

L GEN T or **R GEN T**

Each AC generator is cooled and lubricated by its own independent oil system, which is cooled by a Fuel Cooled Oil Cooler (FCOC). A generator overheat warning is triggered when the oil temperature exceeds 165°C at the generator outlet, and could be indicative of an imminent generator or oil cooling system failure. If the oil temperature continues to increase, beyond a specific limit, a thermal disconnect will initiate. This will result in the display of the associated generator warnings.

Procedure

1. Land..... As soon as practicable

GEARBOX FAILURE

Gearbox Failure (incl. Services lost)

(1B-B-15-44-33-00A-141A-A Issue 008)

Description

In normal operation each gearbox initiates to drive its accessories when the respective engine is operating and terminates this function when the engine is shut down. The SPS computers are able to detect the following failure cases:

Loss of Mechanical Drive:

– The gearbox speed is lower than the speed of the respective engine.

Engine Flame-out:

– The engine speed is lower than the idle speed.

In both cases the SPS computer automatically recovers the failure by initiating cross-bleed to drive the de-coupled gearbox. The failed gearbox is driven by the relevant Air Turbine Starter Motor at 60% speed using air from the opposite engine (engine flame-out) or from any of the engines (loss of mechanical drive).

NOTE

For the TWS it is necessary that both AIRDRIVE switches are in AUTO position.

Loss of Mechanical Drive

When the computer detects that the gearbox speed is lower than the engine speed (-10%), it declares a loss of mechanical drive and initiates the cross-bleed sequence. Two seconds after the detection of loss of mechanical drive, the computer checks the gearbox speed:

– If the speed is above 65% it is assumed to be a false signal and cross-bleed is terminated.
– If the speed is below 65%, loss of drive, i.e. cross-bleed, is confirmed and the <POT> failure warning is triggered. In parallel a CROSS BLEED IN PROGRESS message is displayed on the MHDD.

The cross-bleed is continued in two different ways, depending on the failure (PTO or GBOX) as follows:

PTO Shaft Failure:

– The ATSM accelerates the gearbox speed up to 60% speed and subsequently modulates the control valve to maintain this speed within a given tolerance.
– If the x-bleed is initiated due to a PTO failure, the L or R POT warning is locked in by the software. The faulty gearbox continues to be driven by cross-bleed.

Gearbox Failure:

– Following a gearbox failure (the SPS computer cannot detect if a POT shaft or gearbox failure has occurred when it detects loss of mechanical drive) the shear neck failure immediately occurs, the gearbox speed drops suddenly and the

ATSM is commanded to accelerate. However, due to the very high resistant torque caused by the gearbox seizure, the ATSM is not able to accelerate the gearbox to the steady state. Thus an ATSM under speed condition is detected (less than 20%) and after 20 seconds the x-bleed operation is terminated. The GBOX warning is triggered when the gearbox speed drops below 50%.

NOTE

The GBOX warning is only triggered when the two following events occur at the same time:

- CROSS-BLEED DUE TO LOSS OF MECHANICAL DRIVE (GEARBOX SPEED BELOW ENGINE SPEED).
- GEARBOX SPEED DETECTED BELOW 50%.

Engine Flame-out

When the SPS computer detects the engine speed below idle (-5%) and the gearbox speed is below 80%, it declares an engine flame-out. Gearbox speed is also used because at very high engine idle speed (high altitude) a false engine flame-out signal could be produced.
Once flame-out is confirmed, cross-bleed is activated. Two cases can occur:

- If the ATSM reaches 60% while the gearbox is still higher, the computer commands the ATSM control valve to maintain a constant speed of 60%. When the gearbox reaches the 60%, the ATSM gearbox freewheel is automatically engaged and the speed is maintained at 60% within a given tolerance. At the same time the engine speed decreases down to windmill speed. This sequence is also applicable during a deliberate engine shut down.
- If the ATSM reaches the gearbox speed below 60% the SPS computer controls the valve to open and to accelerate until the 60% speed is reached again. In case of where the gearbox speed drops below 52 to 55%, prior to the ATSM engagement, the CFG can go transiently off line triggering the relevant DWP warning.

Gearbox Under speed

If a gearbox is driven by the relevant ATSM at 60% speed using x-bleed, this operation is automatically terminated under specific failure conditions. Gearbox under speed means that the gearbox has either seized or the available pneumatic power is not sufficient to drive the gearbox at 60% steady state speed.

Two under speed thresholds are present, set at 50% and 20%.

In case of where the ATSM speed is detected to drop within the range 20% to 50%, the software will interpret this anomaly as a failure within the air system and will react as follows:

- Cross-bleed is operative if due to an engine flame-out. The respective generator will go off line (GEN) but hydraulic power will be available.
- The respective GBOX and GEN warnings are triggered if the gearbox runs below 50%.

In case of where the ATSM speed is detected to drop below 20%:

- X-bleed is automatically terminated when this condition is detected for more than 20 seconds.
- The respective CONT P warnings is triggered.

Services Lost

For services lost on the respective side refer to Table , “Services Lost,” on page 3-27. The following applies to individual services:

- LANDING GEAR-Normal Extension: If the left utilities is lost, normal LDG operation is also lost. However, since the FCS control laws are directly linked to the LDG lever, set the LDG lever always to the DOWN position, when possible, and when the EMGY GEAR handle is used.
- THROTTLES: Set the throttle of the good engine to 70% NL minimum in order to avoid low x-bleed power. If the other throttle has to be shut down, following LP COCK SHUT the throttle may be set back to IDLE to preserve HOTAS functions.
- INTAKE: A reduced envelope has to be obeyed.
- ECS: The ECS is shut down if the aircraft is flying outside the compatibility area. Therefore, set the throttle of the good engine to a maximum value, if possible, and exit the incompatibility area.
- CANOPY, PARK BRAKE, LADDER: A separate on ground chargeable accumulator is available.
- GUN: If the right UTIL is lost, the linkless ammunition box drive is lost and as a consequence the GUN is lost as well.
- CONT P: Following a hydraulics loss the aircraft is restricted to the reversionary envelope. This is also indicated by the REV ENV warning.
- A BRAKE: The airbrake will be forced to in by aerodynamic load.

Services Lost

LEFT UTILS	RIGHT UTILS
Left Cowl NWS Landing Gear normal extension Brake/A-Skid normal In Flight Refueling Probe normal extension Park Brake * Canopy * Ladder *	Right Cowl Airbrake Landing Gear emergency extension Brakes/A-Skid emergency In Flight Refueling Probe emergency extension Gun
* Limited operation is provided by the accumulators.	

L/R Gearbox Failure

L GBOX or R GBOX

L GEN or R GEN

L POT or R POT

L CONT P or R CONT P

L UTIL P or R UTIL P

L COWL or R COWL

NWS left system

A BRAKE right system

ECS if outside compatibility area

REV ENV

1. **Recover ..... Nominal 1g level flight**
2. Throttle affected engine ..... IDLE
3. Altitude ..... Below 47 000 ft
4. Speed ..... Below 550 KDAS / 0.95 M
5. AOA / g ..... 20° / 0 to +2g
6. INTAKE ..... OPEN below 340 KDAS
7. Landing gear ..... DOWN below 290 KDAS as soon as practicable

If L CONT P *and* L UTIL P *are displayed:*

8. EMGY GEAR ..... DOWN

If fuel probe extended or in flight refueling essential:

9. FUEL PROBE switch ..... EMGY OUT

NOTE

If FUEL PROBE OUT / EMGY OUT is selected, auto transfer is denied. The transfer stage must be advanced using the FUEL format XFER softkey.

10. Land ..... ASAP, refer to Table , “Services Lost,” on page 3-27

If POT is flailing and/or damage is suspected:

NOTE

If ECS warning is displayed, increase throttle setting of good engine and exit incompatibility area (Refer to Environmental Control System pag. 1-304).

11. AIRDRIVE ..... OFF
12. Throttle affected engine ..... HP SHUT
13. LP COCK affected side ..... SHUT
14. Land ..... ASAP, refer to Single Engine Operation pag. 3-54 and to Table , “Services Lost,” on page 3-27

AER(EP).1F-EF2000(T)-1

L/R Gearbox Underspeed

L GBOX or R GBOX

L GEN or R GEN

L POT or R POT

1. Throttle affected engine .....IDLE
2. Land .....As soon as practicable

Gearbox Overtemperature

(1B-B-15-44-34-00A-141A-A Issue 010)

L GBOX T or R GBOX T

The integrated common oil system for the AMAD gearbox, CD generator and the Air Starter Motor (ATSM) is provided with adequate oil cooling by the Fuel Cooled Oil Cooler (FCOC).

Each gearbox has an oil level temperature sensor, an oil line temperature sensor and an oil line pressure sensor monitored by the respective SPS computer.

The L GBOX T and/or R GBOX T warning caption, originated by the L and/or R SPS computer, indicates a left and/or right gearbox oil over temperature and/or oil under pressure condition.

These conditions are detected when:

– The oil temperature sensor fitted on the gearbox has not failed, and the oil temperature is higher than 165 °C, and/or
– The oil under pressure indication is detected valid and the pressure is lower than 440 KPa.

The malfunction is either caused by:

– A malfunction of the FCOC. In this case the over temperature is due to a fuel system problem which will eventually cause the CFG to go off line when the temperature reaches its thermal protection limit (L GEN or R GEN displayed).
– A gearbox lubrication failure, i. e. a gearbox pump failure, then the problem is limited to the gearbox oil only.
– A gearbox mechanical train excessive friction. This malfunction will eventually lead to damage of the gearbox due to lack of lubrication.

Set the throttle of the affected engine to IDLE, to reduce the oil temperature by increasing the fuel flow through the re-circulation line and the FDIC. A high power setting will also consume heated up fuel by transferring fresh fuel into the collector tank, reducing the oil temperature as well. However, high power settings will also increase fuel and oil pressure and will eventually lead to higher fuel and oil temperatures.

If the L and/or R GBOX T caption is triggered, the respective gearbox operating time is less than one hour.

NOTE

If FUEL T warning is also displayed it has priority, refer to Fuel Over Temperature pag. 3-18.

1. Throttle affected engine ..... IDLE
2. Land ..... ASAP

If the affected gearbox is being driven by crossbleed:

3. AIRDRIVE ..... OFF

Power Offtake Shaft Failure

(1B-B-15-44-30-00A-141A-A Issue 008)

L POT or R POT

In case of a Power Offtake (POT) Shaft failure a difference in speed results between the engine and the gearbox. When the SPS detects that the gearbox speed is lower than the engine speed (-10%), loss of mechanical drive has occurred. The POT shaft has failed, the gearbox runs down and cross-bleed is automatically initiated to maintain the gearbox at 60% NH. Two seconds after detection of loss of mechanical drive, the SPS computer checks the gearbox speed.

If the gearbox speed is below 65%, cross-bleed is confirmed and the <POT> failure warning is triggered. In parallel a x-bleed message is displayed on the ENG and PA format.

Depending on the failure case, i.e. failure of PTO or GBOX, cross-bleed is continued in two different ways:

– The ATSM accelerates the gearbox to a speed of up to 60% and subsequently modulates the control valve to maintain this speed within a given tolerance.

AER(EP).1F-EF2000(T)-1

– If the x-bleed is initiated due to a PTO failure, the L or R POT warning is locked in by the software. The faulty gearbox continues to be driven by cross-bleed.

The respective engine speed should be reduced to IDLE immediately. This is to reduce the difference in speed between the engine and the gearbox. The ECS is operative provided the aircraft is flying within the compatibility area, otherwise the ECS warning will be triggered after approximately 140 sec.
If the POT shaft is flailing and/or damage is anticipated the gearbox motoring must be stopped by selecting AIRDRIVE to OFF.
Shut down the affected engine to prevent serious damage to the gearbox and/or the engine. Shutting down the AIRDRIVE eliminates cross-bleed causing the ATSM to stop driving the faulty gearbox. Following a complete gearbox shut down a restart via the GBOX push button is unlikely and not considered valuable.

1. Throttle affected engine ..... IDLE
2. Land ..... As soon as practicable

If POT is flailing and/or damage is suspected:

1. AIRDRIVE ..... OFF
2. Throttle affected engine ..... HP SHUT
3. LP COCK affected side ..... SHUT
4. Land ..... ASAP, refer to Single Engine Operation pag. 3-54 and Gearbox Failure (incl. Services lost) pag. 3-25.

SPS Overpressure

(1B-B-15-44-31-00A-141A-A Issue 007)

SPS P

The Pressure Reducing and Shut-off Valve (PRSOV) is a sleeve type valve which is normally closed. It operates in direct flow mode as a pressure reducing and shut off valve during cross-bleed and assisted relight operations. In case of a failure of the PRSOV, the pressure is not reduced and the assisted relight is automatically inhibited by the SPS computer. Cross-bleed is still available.

CAUTION

ASSISTED RELIGHT IS PROHIBITED.

1. Land ..... As soon as practicable.

ATS/M Failure

(1B-B-15-44-32-00A-141A-A Issue 008)

L ATSM or **R ATSM**

The warning **L ATSM** or **R ATSM** is displayed when:

– The ATSM is operating at a speed above 72 % (over speed threshold).
– The ATSM is incorrectly driven by the gearbox, due to freewheel failure in its engaged position.
– An ATSM freewheel slippage (ATSM speed in excess of gearbox speed) occurs.

NOTE

Automatic cross-bleed is inhibited.

In the remote case of an over speed situation, the problem can be corrected by setting the AIRDRIVE to OFF, thus shutting off the pneumatic power to the ATSM.
In general, engine shut down of the affected side is recommended. If the warning, however, is displayed following an assisted engine relight and the TBT exceeds 750° C, the engine must be shut down. Only when reducing the affected engine performance to IDLE in combination with a descent to 10 000 ft or below, will cause the ATSM to run at a speed of up to 85%. At such a speed the ATSM will still suffer significant damage, but the effect of the failure will be contained within the ATSM casing with no adverse effect for the aircraft.

1. Throttle affected engine ..... IDLE
2. Altitude ..... Below 10 000 ft if practicable

HYDRAULIC SYSTEM FAILURES

Double Hydraulic Failure

(1B-B-15-44-40-00A-141A-A Issue 006)

HYD TOT

REV ENV

In flight, upon receipt of this catastrophic warning, the pilot's action is to eject immediately, regardless of environmental conditions. The warning is

AER(EP).1F-EF2000(T)-1

displayed when both hydraulic system pressures are below 140 bar and/or the reservoir fluid level is below 0.5 liter in either system. The hard wired warning is generated by either the pressure switch or the fluid level switch.

The catastrophic warning also indicates a double hydraulics pump supply pressure failure where the time to eject is critical.

Therefore, it is essential to minimize the reaction time and to eject immediately.

NOTE

- IT IS ASSUMED THAT A DOUBLE HYD FAILURE CONDITION WOULD MOST PROBABLY NOT OCCUR AT THE SAME TIME.
- THEREFORE, THE REV ENV WARNING WOULD ALREADY BE DISPLAYED FOLLOWING A SINGLE HYDRAULICS FAILURE, I.E. FOLLOWING THE DISPLAY OF EITHER THE L CONT P OR THE R CONT P WARNING.

If the HYD TOT warning is triggered the associated voice warning DOUBLE HYD FAIL will override all other audios. The REV ENV warning is treated as a high integrity warning and will be secondary in priority to the HYD TOT.

1. Eject

Single Hydraulic Failure

(1B-B-15-44-41-00A-141A-A Issue 009)

L CONT P or R CONT P

L UTIL P or R UTIL P

L COWL or R COWL

NWS left system

A BRAKE right system

REV ENV

Illumination of the L CONT P or R CONT P and the L UTIL P or R UTIL P on the DWP may indicate a hydraulic leakage, line rupture or hydraulic pump failure. The warning (s) are displayed when the respective pressure within the hydraulic and utility systems is below 140 bar and/or the respective reservoir fluid level is below 0.5 liter. If a fluid level of below 5 liter is detected, the respective isolation valve will be closed automatically.

In this condition insufficient hydraulic pressure is available to drive the control surfaces at high demands. Therefore, it is recommended to recover the aircraft immediately to the subsonic envelope for safety reasons. This is indicated to the pilot by the REV ENV warning caption.

Select the HYD format for pressure/fluid monitoring and failure conditions.

The system is designed to instruct the FCCs to freeze the cowl (s) positions to a safe value, i.e. to a position relevant to the present aircraft speed. Decelerating below 340 KDAS the respective cowl (s) must be manually opened to prevent engine surges. The cowl (s) are opened via a spring-loaded INTAKE switch. When the switch is activated to the OPEN position it should be held for at least 42 seconds, regardless of the INT display.

In order to safeguard against subsequent loss of the opposite UTIL system, it is recommended to reduce speed to below 290 KDAS as soon as practicable and lower the landing gear.

If the IFR fuel probe is in the extended position at the time of a left hydraulic or a left utility failure, the probe can not be retracted again and it is hydraulically unlocked in this position. To lock the probe in the extended position the probe must be selected to EMGY OUT.

Simultaneous operation of the airbrake and the EMGY LDG in this condition should be avoided.

Failure of a SPS computer results in the loss of the respective HYD format and DWP information. This includes the relevant HYD format SK function. Failure of the hydraulic sensors will result in blanking of the respective symbol displayed on the hydraulics format.

Services Lost

LEFT UTILS	RIGHT UTILS
Left Cowl NWS Landing Gear normal extension Brake/A-Skid normal In Flight Refueling Probe normal extension Park Brake * Canopy * Ladder *	Right Cowl Airbrake Landing Gear emergency extension Brakes/A-Skid emergency In Flight Refueling Probe emergency extension Gun
* Limited operation is provided by the accumulators.	

1. **Recover ..... Nominal 1g level flight**
2. Altitude..... Below 47 000 ft
3. Speed ..... Below 550 KDAS / 0.95 M
4. AOA/g ..... 20° / 2g
5. INTAKE..... OPEN below 340 KDAS
6. Landing gear..... DOWN below 290 KDAS as soon as practicable
7. Land..... ASAP, refer to Table , “Services Lost,” on page 3-31

If **L CONT P** *and* **L UTIL P** *are displayed:*

8. EMGY GEAR..... DOWN

If fuel probe extended or in flight refueling essential:

9. FUEL PROBE switch..... EMGY OUT

NOTE

If FUEL PROBE OUT / EMGY OUT is selected, auto transfer is denied. The transfer stage must be advanced using the FUEL format XFER softkey.

10. Land..... ASAP, refer to Table , “Services Lost,” on page 3-31

Double Utility Failure

(1B-B-15-44-42-00A-141A-A Issue 006)

L UTIL P **R UTIL P**

L COWL **R COWL**

SLATS

NWS

A BRAKE

BRK FAIL

REV ENV

NOTE

– FOLLOWING AN AUTOMATIC CLOSURE OF BOTH UTILS ISOL VALVES, THE SKS LEGENDS ON THE HYD FORMAT ARE OCCULTED, I.E. MANUAL SELECTION OF ANY ISOL SKS IS INHIBITED.

– A DEDICATED DOUBLE UTILS FAILURE DRILL WILL NOT BE DISPLAYED ON THE WARNINGS FORMAT. IT IS ASSUMED THAT EITHER THE LEFT OR THE RIGHT UTILITY SYSTEM WILL FAIL FIRST, FOLLOWED BY THE OPPOSITE SYSTEM. THEREFORE, THE WARNINGS FORMAT WILL CALL UP THE RELEVANT PROCEDURE OF A SINGLE UTILITY FAILURE, FOLLOWED IF APPLICABLE, BY THE TRIGGER OF THE OPPOSITE SYSTEM.

The **L UTIL P** and **R UTIL P** warnings will be displayed when the pressure in each system drops below 140 bar and/or the reservoir fluid level drops below 5 liter.

If the landing gear is not DOWN and locked at the time of the double UTIL failure condition, landing gear lowering, normal and/or emergency, is lost.

1. **Recover..... Nominal 1 g level flight**

AER(EP).1F-EF2000(T)-1

2. Throttles .....Dry range if practicable
3. Speed.....Reduce below 400 KDAS / 0.8 M
4. Altitude .....Below 45 000 ft
5. AOA / g.....20° / 2 g
6. INTAKE .....OPEN below 340 KDAS

If landing gear is DOWN:

7. Land .....ASAP, refer to Cable Engagement - Approach End pag. 3-59

If landing gear is UP:

7. Land .....ASAP, refer to Landing with Gear Unsafe pag. 3-61

Single Utility Failure

(1B-B-15-44-43-00A-141A-A Issue 006)

L UTIL P or **R UTIL P**

L COWL or **R COWL**

NWS left system

A BRAKE right system

NOTE

– WHERE A L/R UTIL P WARNING IS FOLLOWED BY A L/R CONT P WARNING, THE ACTIONS FOR A CONTROLS PRESSURE WARNING MUST BE FOLLOWED.

– FOR SYSTEM WARNING / BEHAVIOR REFER TO SINGLE HYDRAULIC FAILURE PAG. 3-30.

1. INTAKE .....OPEN below 340 KDAS
2. Landing gear .....DOWN below 290 KDAS as soon as practicable

If **L UTIL P** *is displayed:*

3. EMGY GEAR .....DOWN

If fuel probe extended or in flight refueling essential:

4. FUEL PROBE..... EMGY OUT

NOTE

If FUEL PROBE OUT / EMGY OUT is selected, auto transfer is denied. The transfer stage must be advanced using the FUEL format XFER softkey.

5. Land ..... As soon as practicable, for Services Lost refer to Gearbox Failure (incl. Services lost) pag. 3-25

Hydraulic Over Temperature

(1B-B-15-44-44-00A-141A-A Issue 007)

L HYD T or **R HYD T**

A malfunction within the hydraulic system may cause the hydraulic fluid to overheat, indicated by the illumination of the respective warning caption. The excess heat load will be transferred to the fuel via the FCOC and may result in exceeding the fuel temperature limit as well.

If the **L HYD T** or **R HYD T** warning is being triggered and a fuel leakage is not suspected (no <FUEL T> warning), the throttle of the affected engine should be reduced to IDLE to increase the re-circulation fuel flow through the FCOC. A fuel over temperature condition is normally corrected by increasing fuel flow resulting in increased oil cooling via the fuel cooled oil cooler (FCOC). Alternatively, if this is not possible reduce altitude. A failure within the FCOC will eventually cause the generators to go off line when the temperature reaches its thermal protection limit.

Select the HYD format to check and monitor the respective hydraulics temperature. The warning is displayed when the hydraulics temperature has reached 135 °C.

The affected utilities circuit should be isolated by manually closing the respective ISOL valve. This will help to reduce temperature, provided that the failure is within the UTILS circuit.

NOTE

Following a manual closure of an ISOL valve, pressing the AUTO/MAN SK again will revert the system to AUTO, i.e. the system will automatically re-open the valve, provided the system is still healthy.

Prior to landing the affected ISOL valve should be manually opened again in order to regain redundancy and the NWS, when applicable. The affected cowl will not reset, nor the airbrake, when applicable.

If temperature is not decreasing after isolation of the UTILS system, then the over-temperature condition is probably within the CONTR (HYD) system. Nevertheless, the affected ISOL valve should be re-opened for landing.

1. Throttle affected engine ..... IDLE
2. Altitude ..... Decrease, if possible
3. HYD format ..... Check / monitor HYD temp

If temperature not decreasing:

4. AUTO / MAN (HYD format) ..... Affected side MAN
5. OPEN / CLSD (HYD format) ..... Affected side CLSD, check:

L UTIL P or R UTIL P

L COWL or R COWL

NWS left system

A BRAKE right system

6. INTAKE ..... OPEN below 340 KDAS
7. Land ..... As soon as practicable

Prior landing:

8. AUTO / MAN (HYD format) ..... Affected side AUTO
9. DWP ..... UTIL P not lit
10. Landing gear ..... DOWN

NOTE

After re-pressure, NWS is available. L/R COWL and A BRAKE will not reset.

Air in Hydraulics

(1B-B-15-44-45-00A-141A-A Issue 004)

L HYD A or R HYD A

Grond only

The test of air/gas in hydraulics is performed on engine (s) start-up. If the system (s) detect an air/gas content of 1.0 liter or above, the DWP warning (s) is/are triggered. After being triggered, the DWP warning (s) are latched and can only be reset by a complete power down.

The air/gas content of system 1 and/or system 2 shall also be checked by the ground crew on the MDP.

Ground only

A complete power down is required. After 3 minutes, power up and restart engines:

1. DWP ..... Confirm L HYD A and/or R HYD A not lit
2. HYD format ..... Check L and R reservoir level above 7.0 ltr

If less than 7.0 ltr in either system, cancel sortie.

FCS/AIRDATA FAILURES

FCS/Airdata Failures

(1B-B-15-44-50-00A-141A-A Issue 006)

General

NOTE

Due to the continuous change of the cleared FCS envelope and restrictions, most of the FCC procedures are not repeated here until further notice.

Following any persistent resettable or latched FCS or a fuel transfer failure condition the aircraft shall be recovered and restricted to the specific FCS defined Return to Base (RTB) envelope or to the defined specific failure case envelope.

Additional recommendations:

- Initially the aircraft should basically always be recovered to a 1g, straight and level flight condition (nominal 1g)
- Only symmetric and gentle course changing maneuvers (GCCM) are considered.
- Throttles - Use with care.

Definition of Terms

Nominal 1g Flight

This term is used within the procedures and has the following meaning:

– The pilot should aim to fly wings level 1g flight whenever this limit is required
– Deviations due to atmospheric disturbances during 1 g flight are accounted for.

Limits

Unless stated otherwise, all limitations are to be treated as mandatory, i.e. never to be exceeded limits.

FCS Failure Warnings

DWP Hard wired Warning

REV ENV The warning is generated in parallel to the Normal (S/W) DWP warning caption, in order to provide the required integrity of the overall warning system. The warning will usually be triggered together with other FCS related warnings, or, on its own.

FCS Related Warnings

Reversionary Envelope Warning

REV ENV When this warning caption is displayed on its own, i.e. without any supporting DWP caption, it indicates an unknown FCS failure state, which can be caused by any of the following:

– Longitudinal CG 1 range or Fuel/Store system failed
– Longitudinal CG 2 range failed
– Lateral CG warning
– ADS or IMU failure.
– LEAS failure
– Hydraulic failure.

Other additional information will influence relevant pilot procedures to be followed, e.g. FUEL format CG information or GUH AOA occulted/not occulted.

CG 1 and CG 2 Warnings

CG 1 with or without REV ENV
The hazardous CG warning indicate that the aircraft must adhere to the specific CG 1 or LATERAL CG envelope.

CG 2 with or without REV ENV
Both, namely the CG 1 and REV ENV warnings will occult on occurrence of a CG 2 failure condition. The CG 1 warning is replaced by the CG 2 warning and the REV ENV warning is being re-triggered within 3 seconds again. The aircraft must then adhere to the more restrictive CG 2 zone envelope.
The Hazardous CG warning CG 1 or the Critical CG warning CG 2 are raised, whenever:

– The calculated longitudinal CG exceeds the fwd or aft CG limits as calculated
– Either of the calculated left and right lateral CGs exceeds the absolute lateral limit as defined
– The difference between the left and right lateral CGs exceeds the lateral difference limit as defined
– The difference between the max and the min aircraft masses exceeds the mass accuracy threshold, i.e. mass accuracy not correct
– It is indicated that the status of the external tanks is effectively unknown.

NOTE

When jettison is performed the CG warnings will be suppressed, unless the warning was raised before, in which case it will remain raised.

In addition, warnings are displayed on the FUEL format when the forward or aft longitudinal CGs exceeds the calculated fwd or aft values. This is indicated by a white text on red background, e.g. CG REAR.

Mass or Store Data Loss Warning

FCS MASS with or without REV ENV
The warning indicates the loss of fuel or store data.

AER(EP).1F-EF2000(T)-1

NOTE

– PRIOR TO ENTRY INTO FRS THE MASS MUST BE SELECTED TO STBY AND SUBSEQUENTLY THE STOR FORMAT SHOULD APPEAR. FAILURE TO SELECT THE MASS SWITCH TO STBY AND THEREFORE NOT ALLOWING THE ACS TO COMPLETE ITS CONFIGURATION CHECKS PRIOR TO SELECTING FRS, WILL CAUSE THE FCS MASS AND THE REV ENV WARNINGS TO BE GENERATED.

– SELECTION OF THE MASS SWITCH TO SAFE WILL TRIGGER THE FCS MASS AND REV ENV WARNINGS:

– ON GROUND: BOTH, NAMELY THE FCS MASS AND THE REV ENV WARNINGS ARE LATCHED AND CANNOT BE RESET UNLESS A COMPLETE POWER DOWN HAS BEEN DONE.

– IN FLIGHT: SETTING THE MASS SWITCH BACK TO STBY WILL INITIATE AN ACS IBIT USING THE LAST KNOWN STORE DATA. ON SUCCESSFUL COMPLETION OF THE ACS IBIT THE WARNINGS WILL OCCULT.

Following EJ or SEL jettison the FCS MASS and REV ENV warnings are erroneously raised for about 10 seconds. They should be treated as nuisance warnings.

The FCS MASS warning is used as a global warning and is raised together with the REV ENV warning, if any of the following input warnings are triggered:

– Fuel data loss warning
– Stores data loss warning
– Stores data loss on initialization
– SCAC initialization plausibility check
– External tanks SCAC/Fuel discrepancy
– Hard wired missile fire signal failure.

SLATS Warning

SLATS with or without **REV ENV**

The warning indicates a SLATS failure. Refer to Slats Failure pag. 3-38.

FCS1 and FCS 2 Warnings

General

FCS 1 and FCS 2 warnings may be caused by a wide range of equipment failures within the FCS. As a result, additional failures may be generated such as COWL, NWS, A/PILOT, A THROT, FCS REV or AIRDATA. These additional warnings represent real failures and should be treated under the appropriate failure procedure.

FCS 1 Warning

FCS 1 with or without **FCS RSET**

– Maneuvering is restricted to the FCS AOA valid reversionary envelope
– If the NWS legend on the FCS RSET button flashes in the presence of an FCS 1 failure, NWS and L/D will engage 2 sec. after derotation
– The A/B function in/out and the air intake cowl function may be lost and cannot be reset
– Unnecessary asymmetric throttle operation should be avoided. If throttles are asymmetric and there is a mass flow failure or a TT 2nd failure, the FCS REV will be permanently raised to ensure that the aircraft is recovered to the FCS reversionary envelope, for which default mass flow is valid.

TT failures are presently indicated by the FCS 1 warning. The FCS 1 warning is the only warning that indicates both a TT 1st and TT 2nd failure. On a TT 2nd failure the system defaults to a ISA based temperature. This in turn leads to a TAS error of ~ 7%, which couples through the ADE estimated AOA/ SS. In order to keep the estimated AOA/SS error to small values the g limit of the a/c must be kept to observe the REV envelope.
In the presence of an <FCS 1> warning the AT mode shall not be used for landing approach, i.e. the AT must be disengaged. Single FCC failures (FCS 1) will lead to AT disconnect without the A THROT warning raised. This may lead to incorrect landing speed.

FCS 2 Warning

FCS 2 with or without **FCS 1**

Maneuvering is restricted to the FCS AOA valid reversionary envelope

Air Data Failures

General

First failures of ADT Ps and ADT Pt are already not resettable. Following a second failure condition, no upward reconfiguration is allowed. A first ADS, a first

AER(EP).1F-EF2000(T)-1

IMU or a first ADE failure are raised to allow safe recovery to the FCS REV envelope.

ADT PT AND PS

The design uses standard voter/monitor arrangement to safely address sequential failures. However, simultaneous failures (2 vs 2) cannot be resolved using the quadruplex voter/monitors. Therefore, it has been necessary to introduce fifth sources of Pt and Ps (DECU) to act as arbitrators in the event of such a situation arising.

Ps FAIL

After a second failure of ADT Ps, Ps is switched to DECU Ps, while Pt is still provided by the remaining ADTs. AOA/SS are declared invalid with default values being supplied to the users.

Pt FAIL

After a third ADT Pt failure, DECU Ps and DECU Pt are used to produce the airdata parameters supplied to all users. AOA and SS are declared invalid with default values being supplied to the users.

ADT AOA AND SS

The triplex sourced ADT parameters are each produced as a function of each other and thus cannot be considered as independent signals. Failure of a single parameter will introduce errors to the other two.

TT OR Massflow Failures

FCS 1 with or without FCS REV and REV ENV

The FCS 1 warning is raised following one or more confirmed TT failures, or a confirmed first mass flow failure. The pilot is instructed not to use an asymmetric throttle setting to avoid tripping of the TT monitor. Asymmetric throttle settings will cause a second failure condition with FCS REV and REV ENV being triggered.

Airdata Warning

AIRDATA with or without FCS 1

The AIRDATA warning is raised to allow safe recovery to the FCS reversionary envelope initially using IMU autonomous generated AOA and SS. The following possible failure conditions will trigger the AIRDATA warning:

– Confirmed 1st failure of ADT α/β/Pt/Ps
– A transient failure condition of ADT Ps Pt, or
– DECU Pt/Ps failure (indicated only when AAR).

First Failure of ADT α/β/Pt/Ps

Pt and Ps data are provided by the remaining ADTs. The accuracy of ADT Pt and Ps is only questionable during simultaneous failure (2 vs 2). However, the design protects against simultaneous failure by using DECU pressure data.

When the accuracy of ADT AOA and SS cannot be guaranteed, the IMU produces autonomous AOA and SS, i.e. not slaved to the ADT data. Autonomous AOA and SS however, are only valid for a short duration of time. Therefore the pilot is instructed by the AIRDATA warning to recover to the FCS reversionary envelope, where the ADT AOA and SS accuracy is guaranteed.

DECU Failures

DECU 5th source is failed after 2 DECU Ps or Pt fail.

NOTE

DECU 5th source failure is only indicated during AAR, if applicable. At all other times a DECU 5th failure condition is suppressed.

ADE OR Mass flow Failures

FCS REV with or without AIRDATA ith or without REV ENV

AOA not occulted

– The envelope to be observed is dependent of the type of airdata failure, i.e. AOA first fail
– The FCS control laws remain in FULL LAWS
– The required envelope is precautionary to ensure survivable FCS behavior following a further failure.

The following possible failure conditions will trigger the warnings:

– One or more Air Data Estimator (ADE) failure conditions
– Two or more confirmed mass flow failures with symmetric throttles
– One or more mass flow failures with asymmetric throttles, or
– A transient AOA/SS event.

FCS Reversionary Warning

FCS REV with or without REV ENV

GUH AOA occulted - BARS lit on FCS REV Button

AER(EP).1F-EF2000(T)-1

– The warning is required to ensure safe operation in the FCS REVERSIONARY LAWS, i.e. second AOA failure.

CAUTION

– LARGE KDAS ERRORS MAY EXIST WHEN IN THE FCS FAILURE INDUCED REVERSIONARY MODE

– AT SPEEDS BELOW 200 KDAS, THE DIFFERENCE COULD BE UP TO +/- 20 KDAS AT APPROACH POWER SETTING.

Following AOA/SS second failure, the IMU will provide autonomous AOA and SS only for a very limited period of time (9 sec.). The warnings are raised to instruct the pilot to recover ASAP into the FCS reversionary envelope.

The following possible failure conditions will trigger the FCS REV and the REV ENV warning, and occult the GUH AOA (HUD LDG POF):

– Two or more confirmed failures of ADT Pt/Ps
– Two or more confirmed failures of ADT AOA/SS.

Throttle Link Warning

THROT LK

Possible causes:

– For TWS and SS, the warning will be generated as the result of an internal failure of the Electronic Throttle Box (ETB).
– In addition, the warning indicates the loss of throttle follow up function of one or more throttle boxes.

Other FCS related Warnings

Dedicated Voice Warnings

There are two types of procedural warnings:

– CAT 1: A notification of a hazardous situation that requires immediate action, and
– CAT 4: Advice of a primary failure requiring attention.

The main FCS related CAT 1 and CAT 4 warnings applicable to FCS PH3 are summarized in the table below.

CAT 1 & CAT 4 FCS Warnings

VOICE MESSAGE	CAT	SYSTEM	ACTION
SELECT REHEAT	CAT 4 all POF	if no response after 15 sec, warning is repeated every 12 sec	Select Reheat
AIRFRAME TEMP	CAT 4 NAV & COMB	re-trigger after 30 sec if still present	Reduce/Increase Speed as appropriate
MAX SPEED	CAT 4 NAV & COMB		Reduce Speed
SPEED LOW RECOVER (FPSP1a+ LCC4)	CAT 1 plus **REV ENV** all except GND	below 150 KDAS LDG UP below 110 KDAS LDG DOWN weight off mainwheels	Flight: increase speed

Airframe Temperature Warning

CAT 4 - AIRFRAME TEMP

The airframe temperature warning is raised when:

– Temperature is > 373.16° or < 219.16° K or if total temperature > 390.16 K

The warning can be triggered when:

– at high speed and low altitude, or
– at low speed and at high altitude.

NOTE

The voice warning is only triggered twice then it is suspended.

If at high speed and low altitude:

1. Speed .....Reduce

If at low speed and high altitude:

1. Speed .....Increase

Low Speed Warning

CAT 1 - SPEED LOW RECOVER
At FCS FPSP1a, in general, the warning is triggered *:

– With weight off the nosewheel and
– Below 100 EAS (~ KDAS)**

* All configurations at FPSP1a, i.e. tanks on or tanks off.
** EAS ~ CAS (only minor difference); CAS = KDAS below M 1.0

in addition the low speed warning is driven as follows:

– Weight off nosewheel and altitude < 55 000 ft and < 100 EAS, or
– Weight off nosewheel and altitude = 55 000 ft and Mach < 0.75, or
– Weight off nosewheel and altitude = 65 000 ft and Mach < 1.0

with linear interpolation between 55 000 ft and 65 000 ft.

Max Speed Warning

CAT 4 - MAX SPEED
At FPSP1a the warning is dependent upon the following factors:

For SS and configuration 1, i.e. no tanks:

– Altitude < 55 000 ft and
– Speed (EAS) > 750 kts or Mach > 2.0.

If altitude above 55 000 ft Mach limit is reduced by 0.2 per 10 000 ft, i.e. at 65 000 ft the warning is raised at 1.8 Mach.

For TWS the overall Mach limit is 1.9.

For configuration 3, i.e. one or more 1 000 ltr tanks:

– Altitude < 45 000 ft and
– Speed (EAS) > 675 kts or Mach > 1.8.

If altitude > 45 000 ft max Mach is reduced by 0.3 per 10 000 ft, i.e. at 55 000 ft warning is raised at Mach 1.5. at 65 000 ft at Mach 1.2

NOTE

– THE VOICE WARNING IS ONLY TRIGGERED TWICE THEN IT IS SUSPENDED.

– THE WARNING IS RAISED IF SPEED IS > 750 KEAS.

1. Speed.....Reduce

Slats Failure

(1B-B-15-44-54-00A-141A-A Issue 005)

SLATS

REV ENV

* CAT 3 in GND POF.

The SLATS warning is generated following a detected failure resulting in the loss of the leading edge function. These failures can be either:

– A second detected failure in the leading edge actuator control loop (a single failure results in a FCS 1 warning), or
– A detection of an asymmetric position between the left and the right leading edge wing half slats, or
– A detection of leading edge over speed (hydraulic motor damage).

Failure logic is incorporated to assist the pilot to control the aircraft in the event of a 'freeze` or reduction in speed of the L/E SLATS.

The logic reduces both pitch and roll full stick authority.

To prevent structural damage and handling degradation with the LE SLATS extended, the airbrake should be selected to IN and the speed reduced to below 400 KDAS/0.8 M. Once below 400 KDAS/0.8 M do not accelerate above this speed value again.

A failure of one utility system has no effect on aircraft handling, however reduces hinge moment (max drive torque). A second failure, i.e. the loss of total (double) utilities and/or a mechanical failures (shaft breaking etc.) will freeze both slats at their present position.

1. **Recover ..... Nominal 1 g level flight**
2. Throttles ..... Dry range if practicable
3. Speed..... Reduce below 400 KDAS/0.8 M
4. Altitude ..... Below 45 000 ft
5. AOA / g..... 20° / 2 g

Prior to landing:

6. Landing gear ..... Down below 250 KDAS
7. Final approach / landing..... Do not flare

Approach and landing with x-wind above 25 kt:

8. AOA / g..... 12° / 2 g

AER(EP).1F-EF2000(T)-1

Air Intake Cowl Failure

(1B-B-15-44-55-00A-141A-A Issue 006)

L COWL or **R COWL**

CAT 3 during GND and T/O POF.

The warnings L and/or R COWL are generated following a detected failure resulting in the loss of the left or right, or both cowl functions. Cowl failures cannot be reset. These failures can be either:

– A failure detected in either the left or the right or both air intake cowl actuator control loop, or

– A failure of the respective or both hydraulic/ utilities systems.

A failure of one hydraulic system and one FCC lane failure (electrical) on the other hydraulic system, leads to the loss of both intake cowls. Manual operation to the OPEN position is still possible.

In the event of a failure of the automatic scheduled system the start solenoid valve(s) is (are) de-energized and the current cowl lip(s) position is (are) hydraulically locked to a safe position.

It can be assumed that the cowl(s) are frozen to a safe value by the FCC monitors, i.e.:

– to 0° (true) cowl angle when flying above 0.4 M, or

– to -26° (true) cowl angle when flying below 0.35 M.

Failure conditions of either cowl will have no effect on the manual operation of the emergency INTAKE control. In case of a total electrical DC failure (PP3 and PP4), the system reverts to battery power for appr. 10 minutes.

In the absence of a detected failure, setting the emergency cowl INTAKE switch to the OPEN position will have no effect on the automatic cowl control.

The INTAKE emergency control switch commands the respective cowl(s), either left or right or both, to move downwards as long as the switch is held to the OPEN position. The system will automatically select the faulty cowl or both cowls, respectively.

The INTAKE emergency control switch enables to inch the cowl lip to the open position by means of:

– Hydraulic pressure in the case of electrical failure, or

– Aerodynamic load, in case of hydraulic supply failure.

NOTE

To open the cowl, the INTAKE switch must be held to OPEN for 42 seconds regardless of the cowl position indicator.

1. INTAKE.....OPEN below 340 KDAS

Probe Heater Failure

(1B-B-15-44-58-00A-141A-A Issue 005)

PROBE 2 *

* CAT 3 in GND POF.
A PROBE 2 warning can be caused by one or more ADT heater failures.
In general heater failures are unlatched and can self-reset under certain circumstances, e.g. power restored after a power interrupt. A total temperature probe failure produces a latched PROBE 2 warning which cannot be reset.

1. Icing conditions.....Exit/avoid

Airbrake Failure

(1B-B-15-44-62-00A-141A-A Issue 004)

A BRAKE

The warning is displayed when:

– A failure is detected in the airbrake actuator control loop, or
– A failure is detected in the duplex airbrake selector switch voter/monitor, or
– In the case of a right (system 2) hydraulic/ utilities failure.

The airbrake will retract under the following cases:

– Hydraulics loss under aerodynamic loads, or
– Electrical failure under hydraulic pressure.

1. Airbrake .....Select in, check HUD

If Airbrake not in:

2. Speed .....Below 0.7 M

Baro Set Failure

(1B-B-15-44-63-00A-141A-A Issue 009)

BARO-SET

AER(EP).1F-EF2000(T)-1

The BARO-SET warning is either caused by the loss of standard setting 1013 mb (switch to left) or the loss of manual setting (switch UP or DOWN) or both. If a failure occurs which leads to the inability to alter the current setting and the BARO-SET warning is displayed, a reversionary baro pressure channel select option is available via the YAW trim facility. The availability of a source is identified to the pilot via extinguishing of the warning after 60 seconds. In case the warning is still illuminated after 60 sec, both sources have failed and the manual function irreversibly lost for that power cycle. However, a manual selection procedure is recommended regardless of warning duration.

To select a source, push the yaw trim switch to either the left (AVS sourced) or right (UCS sourced), and then operate the toggle switch and observe the displays for movement. Whilst operating the yaw trim switch to select a channel do not try to operate the toggle switch as this affects the moding decisions.

If the value changes then the healthy channel has been selected else try the other channel. If neither channel is operational then the system has suffered a double failure and is irreversibly lost for that power channel. Manually selected channel is only active for 20 seconds from the push of the yaw trim switch. To restart the timer push the yaw trim switch again in the same direction. This can be performed as many times as required during flight.

If standard setting (1013 mb) is not possible:

Ensure baro toggle switch is centered, then:

1. Baro toggle switch.....Move UP or DOWN

If the BARO setting does respond upon operation of the switch to UP or DOWN:

2. No further action
3. Use manual selection, when required.

If the BARO setting does not respond upon operation of the switch to UP or DOWN, use REV Baroset procedure:

CAUTION

IN THIS CASE STANDARD SETTING MAY BE AVAILABLE, BUT SELECTION WILL RESULT IN THE LOSS OF THE LAST MANUAL VALUE SET.

2. Yaw trim switch .....Push either left or right
3. Baro toggle switch.....Attempt to adjust value, observe LGS/ HUD display

If LGS/HUD is not responding:

4. Yaw trim switch ..... Push to opposite side
5. Baro toggle switch ..... Attempt to adjust value, observe LGS/ HUD display

BARO-SET

If still no baro-set response or warning does not extinguish:

– BARO set facility is lost for the remainder of the flight
– Previously manually selected value is retained/ restored.

Datum Adjust/Trim Failure

(1B-B-15-44-64-00A-141A-A Issue 006)

Description

TRIM

The warning is displayed following:

– A lane disparity of the pitch/roll/yaw trim switch.
– Pitch, roll and yaw trim runaway condition.
– Failure of the DATUM ADJUST/TRIM switch.

The pitch, roll and yaw trim demands are time monitored in order to detect trim runaways. If any trim switch axis has been failed, it will fail all three axis and set all trims to zero. This is indicated by the TRIM warning on the DWP.

Should the failure (s) disappear, the monitors will automatically reset. The TRIM warning will occult and the trims will return to normal operation.

DATUM ADJUST TRIM Switch

DATUM ADJUST Position

At FPSP1a and 1a+ the Autopilot (AP) is not available. Therefore the DATUM ADJUST switch position should be TRIM (rear).

If the switch is in the DATUM ADJUST position the time out failure, if activated, will also display the A/ PILOT warning. As a consequence the switch changes state to TRIM and the associated TRIM mode time out monitors will fail as well.

TRIM Position

The TRIM position is used when manual trim inputs to the primary CL are required.

Manual Trim Runaway

In the event of a manual trim switch hard over, a time based runaway monitor will trip after 30 seconds and

the CAT 3 TRIM caption plus voice TRIM are raised. All manual trims will be disabled and manual trim offsets faded to zero over 2 seconds. Automatic trimming function will remain operative. Should the fault clear, the manual trim system will rest automatically. Note that continuous manual trim inputs by the pilot of greater than 30 seconds will cause the runaway monitor to trip. In this case releasing the switch will allow the system to reset.

Automatic Roll trim (ART) Failure

The ART uses attitudes measured by the IMU. If IMU attitudes become invalid, the ART will be disabled. In this case, the CAT 2 FCS REV plus hard wired REV ENV warnings will be raised. The manual roll trim system will continue to function normally.

DATUM ADJUST/TRIM Switch failure

Following a DATUM ADJUST/TRIM switch failure the switch defaults internally to the DATUM ADJUST position. All trim functions are disabled.

Low Speed Recovery

(1B-B-15-44-67-00A-141A-A Issue 005)

Description

The low speed CAT 1 warning “SPEED LOW RECOVER” is accompanied by the REV ENV warning and is generated under the following conditions:

- 150 KDAS AND weight off the mainwheels LDG UP.
- 110 KDAS AND weight off the mainwheels LDG DOWN.

WARNING

PILOTS SHOULD RECOGNIZE THAT, WITH THE LDG DOWN, THE LOW SPEED WARNING OFFERS NO PROTECTION AGAINST THE AIRSPEED FALLING BELOW THE MINIMUM CLEARED 110 KDAS.

The REV ENV hard wired warning is triggered in parallel with the CAT 1 Low Speed Warner in order to achieve a high integrity. Therefore, in the event that the REV ENV warning is generated as a stand alone warning, the pilot must immediately check for a low speed condition and take action appropriately based on displayed airspeed.

Procedure

In the event that the pilot perceives that the airspeed is likely to reduce below the minimum cleared value (110 KDAS baseline) in nose high flight (gamma > 30°), the following procedure should be applied:

- Select Max Reheat.
- If close to the vertical, push/pull towards the nearest horizon until climb angle reduces through 70° gamma.
- Center the pitch stick and roll to maintain 90° bank until the speed increases above 110 KDAS again.
- To assist the recovery, full bottom rudder may be applied until the necessary reduction in climb angle is achieved to establish increasing airspeed.
- If one reheat or engine fails during the recovery, set both throttles to Max dry power.
- If the aircraft departs: EJECT.

In the event that the Low Speed/REV ENV warnings are generated, the following actions should be taken:

Climb Angles less than 30°:

- Increase thrust and/or reduce climb angle to ensure airspeed remains above minimum cleared value (110 KDAS). At the steeper climb angles, rolling inverted and pulling down or banking to 90° is beneficial.

Climb Angles more than 30°:

- Carry out Emergency Nose High Low Speed Recovery Procedure.

Operational Advice

The Low Speed Warner is valid as a cue for the initiation of the Emergency Nose High Low Speed Procedure defined above for climb angles up to 45° gamma.

For climb angles above 30° gamma (subject to aircraft mass/thrust/level/airbrake position), the airspeed may decrease significantly below the minimum cleared airspeed (110 KDAS baseline). Nevertheless, departures from controlled flight are unlikely if the procedure is correctly carried out.

The critical parameter for a successful recovery is maintaining the bank angle as close as possible to 90°.

For climb angles steeper than 45° gamma, the Low Speed Warner cannot be relied upon as a cue for initiating the Emergency Nose High Low Speed

AER(EP).1F-EF2000(T)-1

Recovery Procedure and an additional speed allowance is required.

It is therefore recommended that all maneuvers involving steep climb angles (> 30°) and low airspeeds (< 250 KDAS) are pre-planned so as to ensure that the maneuvers can be completed without the airspeed decreasing below the minimum cleared speed for the configuration (110 KDAS-baseline).

Autothrottle Failure

(1B-B-15-46-17-00A-141A-A Issue 004)

A THROT

At FPSP1a and FPSP1a+ no Autopilot is available. Press ICO to reset the system. If the warning is still illuminated, the Autothrottle function is lost.

1. ICO.....Press

If warning remains:

2. Do not use Autothrottle.

AVIONIC SYSTEM FAILURES

Radar Shut Down/Total Failure

(1B-B-15-47-01-00A-141A-A Issue 006)

Radar Shut Down

RADAR SD

When the CAT 3 warning Radar Shutdown is indicated by RADAR SD on the DWP with voice warning 'RADAR SHUTDOWN' the Radar will be in an overheat condition and should be switched to STBY first and then to OFF, to avoid damage to the equipment. It will automatically shutdown at a defined temperature. Auto shutdown can be overridden by selecting the Radar Protective Interlock Override switch on the left console in the front cockpit to OVRD. Prolonged operation may lead to a total radar failure with the interrogator function being lost also. The interrogator should be switched to OFF.

1. RDR .....SBY
2. RADAR (gangbar).....OFF
3. INT (gangbar).....OFF

Radar Total Failure

RADAR

IFF INT

A total Radar failure is indicated by the CAT 3 warning RADAR on the DWP with voice warning 'RADAR'. The failure can be seen on the Elevation, PA, and Attack MHDD formats. An IFF Interrogator failure will be displayed as secondary warning. All radar and interrogator related functions are lost and autonomous weapon aiming is severely degraded. The radar should be switched to SBY, if SBY on the MDE is still effective to avoid futher damage to the high voltage equipment, and then to OFF. Radar total failure is suppressed when radar is OFF. The interrogator should be switched to OFF also.

1. RDR..... SBY, if possible
2. RADAR (gangbar) ..... OFF
3. INT (gangbar) ..... OFF

Inertial Navigation Failure

(1B-B-15-47-03-00A-141A-A Issue 006)

Description

LINS

A Laser Inertial Navigation System (LINS) failure is indicated by a cat 3 warning on the DWP, attention getters and voice message. In addition the NO MONITOR caption is displayed on the HUD because the HUD flight path data can no longer be monitored. The navigation mode automatically reverts to the next best mode; FCS GPS, or FCS FIX if GPS is unavailable or invalid. Due to the reduced accuracy of the FCS derived data, bank angle, climb/dive and heading indications may be less accurate. 43° NWS is lost, but reverts to mid speed (±28°) and lift dump does not cancel.

Procedure

1. HUD/GUH..... Cross monitor pitch and bank

Other indications and consequences:

– NO MONITOR displayed on HUD
– A degradation in accuracy for climb/dive angle and a slight inaccuracy in the displayed bank angle and heading
– NWS 43° is lost, NWS reverts to mid speed (± 28°)
– Lift dump does not cancel.

AER(EP).1F-EF2000(T)-1

Radar Altimeter Failure

(1B-B-15-47-04-00A-141A-A Issue 002)

RAD ALT

A Radar Altimeter (RAD ALT) failure is indicated by a cat 3 warning on the DWP, attention getters and voice message. In the event of failure of the radar altimeter no RAD ALT data will be available, climb to a safe height above the local terrain and use the barometric altimeter display on the HUD for height information.

Navigation Computer Failure

(1B-B-15-47-05-00A-141A-A Issue 005)

Description

NAV CPTR

A failure of the navigation computer is indicated by a cat 3 warning, attention getters and a voice audio message.

NOTE

RAD ALT remains available on HUD but the low height warning is lost.

In the event of a navigation computer failure both navigation, route and steering information will not be displayed. 'NO MONITOR' will be displayed on the HUD, LINS remains available for flight path displays only, and TACAN data also remains available.
Control of the avionics bus is automatically assumed by the attack computer.

Procedure

1. HUD/GUH ..... Cross monitor pitch and bank

NOTE

FCS audio warning may spuriously play once.

Navigation control is assumed by the attack computer, resulting in the following consequences:

– NO MONITOR displayed on HUD
– Climb/dive angle has reduced integrity
– The low height warning is lost
– Navigation and steering displays lost
– LINS available for flight path displays only
– TACAN data available

TACAN Failure

(1B-B-15-47-06-00A-141A-A Issue 004)

TACAN

TACAN failure is indicated by a cat 3 warning on the DWP, attention getters and a voice message.
In the event of TACAN loss no range or bearing information is available.

Attack Computer Failure

(1B-B-15-47-07-00A-141A-A Issue 005)

Description

ATK CPTR

Failure of the attack computer is indicated by a cat 3 warning on the DWP, attention getters and a audio voice warning.

Procedure

NOTE

FCS audio warning may spuriously play once.

Attack bus control is assumed by the navigation computer
The following facilities are lost:

– All radar functions
– IFF mode C (height transmitted, 0 ft)
– IFF mode selection
– IFF NORM/SBY selection
– IFF IDENT

Single/Double CIU Failure

(1B-B-15-47-08-00A-141A-A Issue 004)

Description

CPT DISP

In the event of a single Computer Interface Unit (CIU) failure the system will revert automatically to the second CIU and no further action is required. The

failure is indicated by a cat 3 warning, attention getters and a voice warning.

A double CIU failure is indicated by the accompaniment of the CPT DISP caption on the DWP, a reversionary voice warning and will result in the following:

– The cockpit data bus is disabled
– The DWP switches to reversionary mode
– The MHDD soft-keys and the HUD moding keys are inoperative
– The left glareshield is not lit
– The dedicated readout panel on the right glareshield is not lit
– Switches and controls for systems that interface via the CIU are inoperative, refer to Table , “Switches and Controls Lost,” on page 3-44.

NOTE

Following a double CIU failure manual selection of MHDD formats and POF is not possible. However, when the landing gear is selected to DOWN the landing POF default formats will automatically be displayed on the MHDD.

Switches and Controls Lost

SWITCH/CONTROL LOCATION	SWITCH/CONTROL
Stick	Weapon Select
	A - A Weapon Release
	Radar Mode
Left Rear Console	Intercom Volume
	Microwave Landing System Volume
	Missile Audio Volume
	TACAN Beacon Volume
	Secure Data Erase
Throttles	Scanner Elevation
	X - Y Controller and Insert
	Voice Warning Suspend
	SRAAM Reject
Right Forward Console	Environmental Control System
	Computer Symbol Generator
Right Rear Console	Radar Altimeter
	Transponder
	Radar
NOTE Whilst the Master Arm Safety Switch remains functional, its status indication on the G/S, HUD and MHDD is inhibited.	

Procedure

1. Land ..... As soon as practicable

Other indications:

– DWP switches to reversionary mode
– MHDD soft-keys and HUD moding keys inoperative
– Left glareshield not lit
– Dedicated readout panel not lit
– CIU interface switches and controls inoperative.

AER(EP).1F-EF2000(T)-1

Double Rear CIU Failure

(1B-B-15-47-08-00B-141A-A Issue 003)

REAR CIU

A double rear CIU failure is indicated by a cat 3 warning displayed on the DWP, attention getters and voice message. The indications listed apply only to the rear cockpit.

Other indications:

- Dedicated read out panel not lit
- LHGS not lit
- CIU interface switches and controls inoperative.

Single/Double CSG Failure

(1B-B-15-47-09-00A-141A-A Issue 004)

Description

CPT DISP GUH

REV ENV

In the event of a single Computer Symbol Generator (CSG) failure, the 'CSG' caption will be displayed on the Dedicated Warning Panel (DWP). The system will select the second CSG without any action from the pilot. This failure is indicated by a cat 3 warning, attention getters and a voice warning; no actions are required.

It is possible that when the system selects the second CSG the selection may not be correctly performed, in which case the pilot will not only see the 'CSG' caption on the DWP and receive a voice warning, but may also suffer loss or corruption of some of the MHDD formats, (high integrity flight data on the HUD will not be affected). In this case, the pilot may manually select the CSG NORM/REV switch to either position, selecting the position that gives him the correct display operation.

A double CSG failure is indicated by the accompaniment of the 'CPT DISP' caption on the DWP and a voice warning; the following conditions will also become apparent:

- DWP switches to the reversionary mode (indicated by the REV switch becoming boxed)
- Loss of all HUD and MHDD symbology
- MHDD soft-keys will not be lit
- Reversionary mode voice warnings
- Loss of video to the Video/Voice Recorder (VVR).

Procedure

1. Land.....As soon as practicable

Other indications:

- DWP switches to reversionary (REV) mode
- HUD and MHDD symbology is lost
- MHDD soft-keys blank.

Double CSG/CIU Failure

(1B-B-15-47-17-00A-141A-A Issue 003)

Description

CSG with CPT DISP

or

CIU with CPT DISP

Double CSG/CIU failure is indicated by cat 3 warnings, attention getters and voice messages. A double CIU failure, will result in the following:

- The cockpit data bus is disabled
- The DWP switches to reversionary mode
- The MHDD soft-keys and the HUD moding keys are inoperative
- The left glareshield is not lit
- The dedicated readout panel on the right glareshield is not lit
- Controls and switches for systems that interface via the CIU are inoperative, refer to Table , "Systems Controls and Switches Rendered Inoperative During Double CIU Failure," on page 3-46.

NOTE

Following a double CIU failure manual selection of MHDD formats and POF is not possible. However, when the landing gear is selected to DOWN the landing POF default formats will automatically be displayed on the MHDD.

AER(EP).1F-EF2000(T)-1

Systems Controls and Switches Rendered Inoperative During Double CIU Failure

SWITCH/CONTROL LOCATION	SWITCH/CONTROL
Stick	Weapon Select
	A-A Weapon Release
	Radar Mode
Left Rear Console	Intercom Volume
	Microwave Landing System Volume
	Missile Audio Volume
	TACAN Beacon Volume
	Secure Data Erase
Throttles	Scanner Elevation
	X-Y Controller and Insert
	Voice Warning Suspend
	SRAAM Reject
Right Forward Console	Environmental Control System
	Computer Symbol Generator
Right Rear Console	Radar Altimeter
	Transponder
	Radar
NOTE Whilst the Master Arm Safety Switch remains functional, its status indication on the G/S, HUD and MHDD is inhibited.	

During a double CSG failure, the following conditions will be apparent:

– DWP switches to the reversionary mode (indicated by the REV switch becoming boxed)
– Loss of all HUD and MHDD symbology
– MHDD soft-keys will not be lit
– Reversionary mode voice warnings
– Loss of video to the Video/Voice Recorder (VVR).

Procedure

If double CSG/CIU failure:

Indications are:

– DWP switches to reversionary mode
– MHDD and HUD symbology is lost
– MHDD soft-keys not lit
– Left glareshield not lit (CIU only)
– Dedicated readout panel not lit (CIU only)
– CIU interface switches and controls inoperative (CIU only)

1. Land ..... As soon as practicable

GPS Failure

(1B-B-15-47-10-00A-141A-A Issue 005)

Description

GPS

with or without GPWS

A GPS failure is indicated by a cat 3 warning, attention getters and an audio voice message.

In the event of a GPS failure the navigation system will automatically revert to the best available mode. The velocity monitor function is not available under these conditions. The navigation modes available after a GPS failure are:

Mode 3	LINS and manual fixing (integrated by Kalman filter)
Mode 5	LINS and manual fixing
Mode 8	FCS and manual fixing.

As the velocity monitor is not available the climb/dive angle could be degraded due to LINS velocity errors and ‘NO MONITOR’ will be displayed on the HUD.

Procedure

Climb/dive angle degraded and NO MONITOR displayed on HUD.

1. HUD/GUH..... Cross monitor pitch and bank
2. NAV sources ..... Cross monitor

AER(EP).1F-EF2000(T)-1

Monitor Trip

(1B-B-15-47-12-00A-141A-A Issue 005)

Description

MON TRIP

A monitor trip is indicated by a cat 2 warning on the DWP, attention getters, an attenson and voice message whilst airborne. On the ground it is indicated by a cat 3 warning, attention getters and a voice message.

When in the primary navigation mode (LINS and GPS integrated by Kalman filter) the navigation computer compares the data outputs of the LINS, GPS and FCS. The LINS northings/eastings and vertical velocities data are compared with those from GPS, and the LINS bank and inclination data are compared with FCS outputs. When a discrepancy in subsystem outputs is determined to be beyond specified limits, the navigation computer generates the MON TRIP warning.

After a monitor trip, LINS data is displayed on the HUD, and climb/dive angle, bank and vertical velocity are displayed on the HDHUD format, with the navigation data source soft-key indicating SPLT (split). The climb/dive angle displayed on the HDHUD format is derived from the navigation computer, whilst bank and vertical velocity is derived from the FCS. The navigation computer cannot determine which source is in error, therefore pilot assessment of flight path displays, using whatever additional references are available, is required to determine the best source for use for flight path management.

Procedure

Disparity between LINS and FCS / GPS parameters:

1. HUD/GUH ..... Cross monitor pitch and bank
2. NAV sources ..... Cross monitor
3. HDHUD ..... SRCE select appropriate data source

Navigation Source

SELECTED SOURCE	HUD	HDHUD
SPLT	LINS	BEST NAV
LINS	LINS	LINS
NAV	BEST NAV	BEST NAV

IFF Interrogator Overtemperature

(1B-B-15-47-13-00A-141A-A Issue 004)

INT T

When the system detects the overheat warning condition a category 3 warning will be generated. Deselection of multiple mode selections and/or decreased interrogation volume may clear the warning condition. The system will continue to operate until the overheat temperature limit is reached. Once the limit is reached the interrogator will automatically shut down, but may be recycled when overheat temperature limit is no longer exceeded.

1. Deselect multiple mode selections and/or decrease interrogation volume.

   The interrogator will shut down automatically when the overheat temperature limit is reached. The interrogator may be recycled when INT T goes out.

IFF Warnings/Failures

(1B-B-15-47-16-00A-141A-A Issue 005)

IFF Automatic Code Change Available Warning

When Transponder ACC codes have been loaded, their start time has begun and the ACC has not been selected, the category 4 voice warning “Transponder A.C.C. available” will be provided.

IFF Mode 4 Incorrect Own Response Warning

When the system detects that the transponder failed to provide and/or complete a Mode 4 response, the category 4 voice warning “Mode 4 Response” will be provided.

The warning may be canceled by either selecting Mode 4 or deselecting the response warning using the XY controller on the Mode 4 response icon.

IFF Mode 4 Incorrect Target Response Warning

When Mode 4 is selected and an incomplete Mode 4 response is received from the target, this will be indicated by the characters “Mode4” with the associated IFF track or plot on the AF.

IFF Interrogator or Transponder Cryptovariable Failure (Mode 4)

IFF CRYP

The cryptovariable warning, category 3, is generated in the following cases:

– No cryptovariable codes have been loaded.
– The cryptovariable codes have been cleared during operation.
– A fault occurred in the IFF crypto module.
– The crypto erase function has been selected.

1. ATK format.....Mode 4 response icon, deselect if practicable
2. MISC .....CRYP SUPP, press

As a consequence the Mode 4 will be lost.

IFF Transponder Failure

XPDR

A failure of the IFF Transponder is indicated by a category 3 warning and the voice warning “Transponder”. Upon XPDR failure inform controlling agency.

IFF Interrogator Failure

IFF INT

A failure of the IFF Interrogator is indicated by a category 3 warning and the voice warning “Interrogator ”.

GPWS Failure

(1B-B-15-47-18-00A-141A-A Issue 004)

Description

GPWS

with or without **TERRAIN**

or **OBSTACL** alone

A GPWS failure is indicated by a cat 3 warning, attention getters and an audio voice message.
In the event of a GPWS failure, alerting for terrain and obstacles will be unavailable.
If GPWS appears accompanied by TERRAIN then terrain and obstacle data have been lost as the present position of the aircraft is outside the terrain data defined area. If TERRAIN subsequently goes out then terrain data has been restored as the aircraft has re-entered the defined area.
If OBSTACLE appears alone, obstacle data has been lost as the present position of the aircraft is outside the obstacle defined area. The system will continue to provide alerting to clear terrain. If OBSTACLE subsequently goes out then obstacle data has been restored.

Procedure

If **GPWS** with or without **TERRAIN**
- Loss of GPWS alerting for terrain and obstacles.

If **OBSTACL** alone - Loss of GPWS alerting for obstacles only (GPWS alerting for terrain still valid).

DASS Computer Failure

(1B-B-15-47-20-00A-141A-A Issue 005)

General

DAS CPTR

A category 3 DAC Failure will have the following consequences:

– MDE Radar channel input lost,
– Radar performance in GUN and VISident mode may be degraded,
– RF interoperability relies on loaded default data,
– MDE CHAFF/FLARE modes lost,

AER(EP).1F-EF2000(T)-1

– Expendables release relies on back-up program loaded in dispensers,
– CHAFF /FLARE switch, forward function lost (default chaff only or expendables program).

MDE Radar channel input lost

When the DAC fails, the MDE MK “RDR CHAN” will be occulted and lost.

Radar performance in GUN and VISident mode may be degraded

Normally the DAC passes the allocated channels and the frequency mode to be used, “fixed” or “agility”, to the radar. If the DAC fails, the radar will continue to operate on the last information received from the DAC. This means the radar will operate with either fixed frequencies or frequency agility. Therefore if fixed frequency was the last mode, the radar modes normally using frequency agility for better performance will operate on fixed frequencies only and performance may be degraded.

RF interoperability relies on default data

In case of a DAC failure, the continuous monitoring of a frequency conflict between transmitters and receivers is lost. As long as 28 V DC is available, the default matrix loaded in the DAC via mission data is still available and will blank receivers on default values, whereby receivers are blanked more often than necessary.

MDE CHAFF/FLARE modes lost

The system relies on back-up mode for expendables release.
Normally, chaff packets are released under software control of the DAC. To provide a reversionary capability in the event of a DAC failure, a back-up expendable program is stored in each dispenser. This back-up program is downloaded from the DAC during the power-up initialization sequence. The back-up program is pre-defined on the ground and will be loaded into the DAC either by

– the GLU with the capability to update it by use of the PDS, or
– PDS, if multi-mission data has not been previously loaded via the GLU.

CHAFF /FLARE switch, forward function lost

The CHAFF/FLARE INITIATE switch has three positions. The forward selection “release default chaff only program or the expendables program selected on the MDEF” will be lost. The aft position “release of default chaff and flares program” will remain operative.

Flare Dispenser Failure

(1B-B-15-47-21-00A-141A-A Issue 003)

Description

FLARE

A Flare failure is indicated by a cat 3 warning, attention getters and an audio voice message.
There is no indication to the aircrew to show that only one or both dispensers have failed. Consequently the aircrew should be aware that flare dispensing is, at best, degraded, or denied completely.

Procedure

Prior to landing:

1. EXPD .....OFF
2. MASS.....SAFE, as soon as possible after landing

Unable to dispense flares from both flare dispensers.

Chaff Dispenser Failure

(1B-B-15-47-22-00A-141A-A Issue 003)

Description

CHAFF

A Chaff failure is indicated by a cat 3 warning, attention getters and an audio voice message.
There is no indication to the aircrew to show that only one or both dispensers have failed. Consequently the aircrew should be aware that chaff dispensing is, at best, degraded, or denied completely.

Procedure

Prior to landing:

1. EXPD .....OFF

NOTE

Unable to dispense chaff from both chaff dispensers.

ECS FAILURES

ECS Failure

(1B-B-15-44-70-00A-141A-A Issue 004)

Description

ECS

If there is no other warning, the illumination of the ECS caption on the DWP indicates that the UCS has detected a single or a combination of the following conditions:

– overpressure, low pressure or overtemperature on the ECS lines
– temperature control failure
– avionic cooling fans functioning without requirement.

If any of the above mentioned conditions occurs, the UCS electrically commands; the variable pressure regulating and shut-off valve and the ECS shut-off valve to close, and the MSOC pressure regulating shut-off valve to open. Precooled air supply to canopy seal, anti-g and MSOG remains. The canopy antimist and demist function is overridden. Simultaneously, the ECS caption comes on.

NOTE

The ECS caption is displayed on the DWP whenever the ECS switch is placed to OFF/RESET and electrical power is on.

Reset the system by setting the ECS switch to OFF/RESET and then to ECS.

– If the ECS caption goes off, continue normal operation.
– If the ECS caption remains on, the flight is allowed only within the emergency ram air (ERA) envelope (see Table , “Ram Air Envelope,” on page 3-50). The ERA envelope is displayed on the right MHDD by selecting the ERA PROF key. Once the aircraft is within limits, place the ECS switch to RAM AIR (ECS caption goes off). If practicable, descend to an altitude lower than 25 000 ft (aeromedical recommendations).

  For altitude above 25 000 ft, be prepared for a cabin low pressure. If it occurs, CABIN LP caption comes on.

Procedure

If no other warning:

1. ECS ..... OFF/RESET then ECS

If unsuccessful:

2. Altitude ..... Below 25 000 ft, if practicable
3. ECS ..... RAM AIR, within limits (warning occults)

Ram Air Envelope

ALTITUDE - FT	MAXIMUM SPEED - KDAS/MACH				
	ISA - 40°	ISA - 30°	ISA	ISA + 20°	ISA + 30°
0	---/---	---/---	535/ 0.81	330/ 0.50	175/ 0.26
5000	---/---	---/---	550/ 0.90	380/ 0.62	335/ 0.56
10 000	680/ 1.24	680/ 1.24	555/ 0.98	400/ 0.72	370/ 0.67
15 000	640/ 1.29	640/ 1.29	545/ 1.05	410/ 0.80	385/ 0.76
20 000	605/ 1.35	605/ 1.35	515/ 1.12	405/ 0.86	385/ 0.83
25 000	565/ 1.40	565/ 1.40	480/ 1.16	390/ 0.91	375/ 0.88
30 000	520/ 1.44	520/ 1.44	430/ 1.20	360/ 0.94	355/ 0.92
35 000	435/ 1.35	435/ 1.35	390/ 1.21	325/ 0.94	320/ 0.93

ECS Fan Failure

(1B-B-15-44-71-00A-141A-A Issue 003)

Description

FAN

Illumination of the FAN caption on the DWP indicates that the avionics cooling fans have failed to operate when required.

WARNING

ANY PROLONGED PERIOD OF FLYING WITHOUT COOLING THE AVIONICS AND GENERAL EQUIPMENT, MAY CAUSE INCREASING EQUIPMENT PERFORMANCE DEGRADATION AND DECREASING RELIABILITY. SUBSEQUENTLY, FLIGHT CONTROL SYSTEM COMPUTERS FAILURE MAY OCCUR.

In flight, after an ECS failure, if the red FAN caption comes on, switch off all non-essential avionic equipment and land as soon as possible within 20 minutes.

Procedure

WARNING

FCS PERFORMANCE CANNOT BE GUARANTEED BEYOND 20 MINUTES.

1. Land..... ASAP

Cabin Low Pressure

(1B-B-15-44-72-00A-141A-A Issue 002)

Description

CABIN LP

Illumination of the CABIN LP caption on the DWP indicates that cabin pressure altitude is above 26 000 ft. The most probable cause of this warning is a secondary result of an ECS failure. Nevertheless, it may be due to a high loss of pressure in the cockpit.
If CABIN LP caption comes on, the AOB is mechanically selected, by means of the aneroid contained within the AOB head. The MSOC caption comes on. After 30 seconds, if the MSOG is serviceable and the altitude is below 35 000 ft, the UCS deselects the AOB allowing the MSOG to re-supply the breathing gas. If practicable, descend to an altitude lower than 25 000 ft (aeromedical recommendations).

Procedure

1. Altitude..... Below 25 000 ft, if practicable

Cabin High Pressure

(1B-B-15-44-73-00A-141A-A Issue 002)

Description

CABIN HP

Illumination of the CABIN HP caption on the DWP indicates that cabin differential pressure is higher than 45 KPa, due to failures of the cabin pressure control valve and the cabin safety valve.
Place the ECS switch to OFF/RESET. The ECS caption will come on. Flight is allowed only within the emergency ram air envelope. The ERA envelope is displayed on the right MHDD by selecting the ERA PROF key. Be prepared for a cabin low pressure indication. If it occurs and if practicable, descend to an altitude lower than 25 000 ft. Once the aircraft is within limits, place the ECS switch to RAM AIR.

Procedure

1. Recover ..... Nominal 1 g
2. Altitude..... Below 25 000 ft, if practicable
3. ECS ..... RAM AIR, within limits

Hot Bleed Air Leak

(1B-B-15-44-74-00A-141A-A Issue 004)

Controlled Hot Bleed Air Leak

ECS

MSOC

If a hot bleed-air leak is detected, the UCS electrically commands both engine bleed shut-off valves to close. There is no supply to any line of the ECS, MSOG, canopy seal, anti-g, antimist/demist and crossbleed.
ECS and MSOC captions will come on indicating that; there is a hot bleed-air leak and, the UCS is commanding the actions to cut-off the hot bleed air leak and select the auxiliary oxygen bottle (AOB).

AER(EP).1F-EF2000(T)-1

The flight is allowed only within the emergency ram air envelope. The ERA envelope is displayed on the right MHDD by selecting the ERA PROF key. Once the aircraft is within limits, place the ECS switch to RAM AIR. Descend to an altitude below 10 000 ft and monitor the AOB contents on the PA format. When AOB contents depleted, disconnect the mask hose and breathe cabin air. Land as soon as practicable.

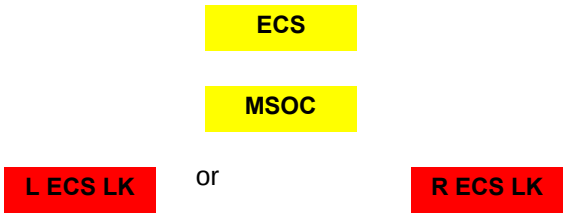
Procedure

1. ECS.....RAM AIR, within limits
2. Altitude .....Below 10 000 ft
3. AOB contents.....Monitor on PA format (use minimum de-clutter)

When AOB contents depleted:

4. Mask Hose .....Disconnect, breathe cabin air
5. Land .....As soon as practicable

Uncontrolled Hot Bleed Air Leak



Illumination of ECS, MSOC and L (or R) ECS LK captions indicate that there is a hot bleed-air leak, the UCS has commanded both engine bleed shut-off valves to close and an engine bleed air shutoff valve does not close (the hot leak is uncontrollable).

There is no supply to any line of the ECS, MSOG, canopy seal, anti-g, antimist/demist and crossbleed. The UCS selects the auxiliary oxygen supply.

Shutdown the related engine immediately. The flight is allowed only within the emergency ram air envelope, the ERA envelope is displayed on the right MHDD by selecting the ERA PROF key. Once the aircraft is within limits, place the ECS switch to RAM AIR. Descend to an altitude below 10 000 ft and monitor the AOB contents on the PA format . Land as soon as possible. When AOB contents depleted, disconnect the mask hose and breathe cabin air.

Procedure

1. Throttle affected engine .....HP SHUT
2. LP COCK affected side.....SHUT
3. ECS.....RAM AIR, within limits
4. Altitude .....Below 10 000 ft
5. AOB contents ..... Monitor on PA format (use minimum de-clutter)
6. Land ..... ASAP, refer to Single Engine Operation and L/R Hydraulic Failure

When AOB contents depleted:

7. Mask Hose ..... Disconnect, breathe cabin air

Smoke or Fumes in Cockpit

(1B-B-15-44-75-00A-141A-A Issue 002)

Description

Consider all unidentified fumes in the cockpit as toxic. Do not confuse condensation from the environmental control system (ECS) with smoke. The most probable source of visible smoke or fumes in the cockpit is from the engine bleed or residual oil in the ECS ducts. This smoke is blue grey in color, has a characteristic pungent odor, and may cause the eyes to sting. Another possible source of smoke or fumes is an electrical malfunction or overheat of equipment located in the cockpit. In the event of electrical short or overload condition, this equipment may generate electrical smoke (usually white or grey in color) but should not cause an open fire since cockpit equipment uses very little electrical current. Cockpit electrical wiring insulation may smolder and create smoke, but will not erupt into a seriously damaging fire.

If smoke or fumes is detected, manually select the auxiliary oxygen bottle (AOB). Go into limits of the Emergency Ram Air envelope. The ERA envelope is displayed on the right MHDD by selecting the ERA PROF. Once within limits, place the ECS switch to RAM AIR. Land as soon as possible.

If electrical smoke is confirmed, switch off all non-essential electrical equipment.

If cockpit visibility restricted, slow and jettison canopy.

Procedure

1. **AOB ..... Select**
2. ECS..... RAM AIR, within limits
3. Land ..... ASAP

If unable to clear smoke:

4. All non-essential electrical equipment .. OFF
5. Canopy ..... Jettison, if necessary

AER(EP).1F-EF2000(T)-1

Oxygen Failures

(1B-B-15-44-77-00A-141A-A Issue 004)

Auxiliary Oxygen Failure

OXY

Illumination of the OXY caption indicates that the oxygen concentration (oxygen partial pressure) is below the minimum requirement and the automatic selection of the auxiliary oxygen bottle (AOB) has failed.
Manually select the auxiliary oxygen bottle by pulling the auxiliary oxygen selector handle (the MSOC caption will come on). Descend to an altitude below 10 000 ft. Check AOB contents during the descent on the PA format (use minimum de-clutter). When AOB contents depleted, disconnect the mask hose and breathe cabin air. Land as soon as practicable.

Procedure

1. **AOB.....Select**
2. Altitude.....Below 10 000 ft

When AOB contents depleted:

3. Mask hose .....Disconnect, breathe cabin air
4. Land.....As soon as practicable

MSOC Failure

MSOC

Illumination of the MSOC caption indicates that the oxygen concentration is below the minimum requirement and the AOB has been selected.
Monitor the AOB contents on the PA format (use minimum de-clutter), and after 1 minute:

– If the warning occults, continue with the mission
– If the warning persists, descent to an altitude below 25 000 ft. If **OXY** is displayed (AOB contents below 70 liters), descent to an altitude below 10 000 ft. land as soon as practicable.

When AOB contents depleted, disconnect the mask hose and breathe cabin air.

Procedure

1. AOB contents .....Monitor on PA format (use minimum de-clutter)

UCS Front Computer Failure

(1B-B-15-44-78-00A-141A-A Issue 004)

UCS CPTR

When a Front Computer failure is detected, the appropriate warning is given on the DWP. The attention getters flash and the "UCS computer" voice warning is given.
The following controlled/monitored services will be lost:

– ECS
– AOB automatic control selection
– Cabin conditioning
– MSOC
– Canopy seal (monitoring)
– Antimist/Demist
– Anti-g.

1. **AOB.....Select**
2. ECS .....RAM AIR, within ECS limits ECS Failure pag. 3-50
3. Altitude.....10 000 ft or below

When AOB supply depleted:

4. Mask hose .....Disconnect, breathe cabin air
5. Land.....As soon as practicable

Windscreen Heater Failure

(1B-B-15-44-79-00A-141A-A Issue 005)

Description

WINDSCR

Windscreen heater failure is indicated by a cat 3 warning on the DWP, accompanied by attention getters and a voice warning message. The failure may be one of overheat, therefore the windscreen heater should always be selected OFF to avoid possible windscreen damage. The anti-mist/demist control should be selected to REV, if windscreen demist is required, but not before selecting the windscreen heater to OFF; an overheat failure and additional heating, via the selection of anti-mist/demist to REV, would certainly cause damage to the windscreen.

Procedure

1. W/S HTR.....OFF

AER(EP).1F-EF2000(T)-1

If mist forms on the Windscreen:

2. DEMIST.....REV

Canopy not Locked

(1B-B-15-44-80-00A-141A-A Issue 004)

Description

CANOPY

Canopy not locked is indicated by a cat 2 warning on the DWP, accompanied by attention getters and a voice warning message. This indicates that the canopy may now be unlocked. As a precautionary measure descend to cabin altitude and maintain minimum practical speed.

Procedure

1. Recover.....Nominal straight and level flight
2. Altitude .....Below 10 000 ft
3. Speed.....Min practical speed

SINGLE ENGINE OPERATIONS

Single Engine Operation

(1B-B-15-46-01-00A-141A-A Issue 006)

General

Regardless which engine has failed, common procedures are available for Transit, Landing and Overshoot. If necessary refer to the Recovery Data pag. 2-30.

Transit

If one engine fails cross-bleed air operation will automatically start as the failed engine is running down to idle, provided that the AIR DRIVE switch is set to AUTO.

The throttle of the failed engine must be retarded to the HP SHUT and the LP COCK switch to the SHUT (guard open). Once the affected engine shut down procedure has been carried out the affected engine throttle may be set into the dry range in order to maintain HOTAS integrity.

Selecting the FUEL XFEED to OPEN interconnects the fuel feed lines of the engines and prevents fuel unbalance.

Only if a fuselage fuel leak is present, the FUEL XFEED must remain in NORM position.

Consider jettisoning stores to reduce mass and improve conditions for an approach within the dry range.

NOTE

ECS will fail if aircraft is flown outside the ECS compatibility envelope.

1. Positive g..... Maintain
2. Fuel ..... Balance as appropriate, refer to Fuel Balancing pag. 3-19

WARNING

DO NOT SELECT XFEED TO OPEN IN THE CASE OF A FUEL LEAK AND/ OR FUEL T WARNING.

3. XFEED ..... OPEN
4. Land ..... As soon as practicable

Landing

Check fuel contents and calculate approach speed. The airbrake should be IN. Confirm that harness is tight and locked.

The approach is normally flown as a straight-in with 13-14° AOA.

Approach speed / AOA same as with 2 engines Pre Landing pag. 2-26

ECS/SPS Compatibility Area

(1B-B-15-44-82-00A-145A-A Issue 001)

NOTE

The graph below is only for a quick reference (there is not a direct relationship between NHR and NH) and assumes single engine operation with crossbleed in progress.

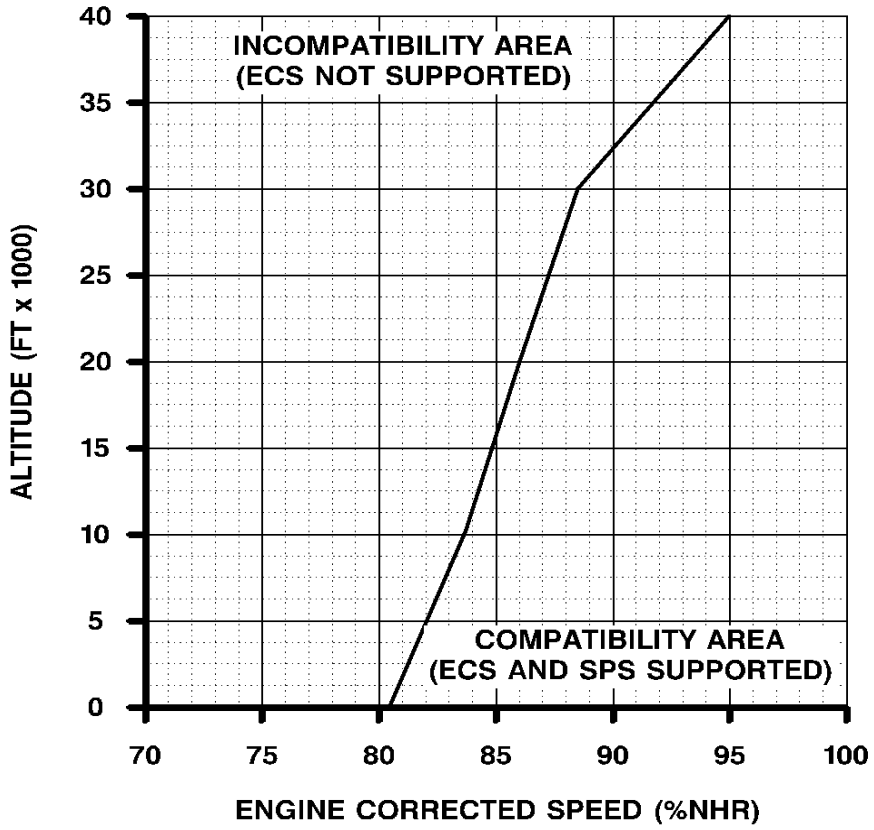


Figure 3.2 - ECS/SPS Compatibility Area

APPROACH AND LANDING EMERGENCIES

Engine Failure On Approach

(1B-B-15-46-02-00A-141A-A Issue 005)

In case of an engine failure on approach, immediately advance both throttles.. The good engine may be modulated up to max reheat to obtain required thrust and provide automatic cross-bleed.
Automatic control law function will raise flaperons and foreplanes to reduce drag and improve overshoot performance. Shut down failed engine when time permits.
If needed, a relight may be attempted.
If decision to land is made, re-establish glidepath at 2,5° glidescope, AOA 13°.
If go-around decision is made, fly wings level, retract gear and climb away at 13° AOA in acceleration, then apply single engine landing procedure (refer to Single Engine Operation pag. 3-54).

1. Throttle good engine ..As required
2. Land .....ASAP, refer to Single Engine Operation pag. 3-54

Nose Wheel Steering Failure Approach / Landing

(1B-B-15-46-04-00A-141A-A Issue 004)

Description

The warning **NWS** (CAT 3 in NAV POF) is triggered under the following condition(s):

- A failure is detected in the nose wheel actuator loop and/or,
- The weight on nose wheel is detected jammed on ground and ADS failure and/or,
- The ICO has been activated with LDG down; in this case the NWS legend on the FCS RSET button is flashing as well.

NOTE

- JAMMED ON GROUND, ALSO CALLED “FLIGHT LATCHED” MEANS: THE FCS HAS SWITCHED FROM GROUND LAWS TO FLIGHT LAWS USING THE BACK-UP SWITCHING LOGIC, I.E. NOT THROUGH WEIGHT OFF NW, BUT USING WEIGHT OFF BOTH MAINWHEELS OR IF THE ALPHA RATE IS ABOVE 6° (PITCH RATE BASED AOA).
- UNLATCHING OF THE “FLIGHT LATCHED” STATE: THIS STATE WILL BE UNLATCHED WHEN WEIGHT ON BOTH MAINWHEELS AND ADS AOA BELOW 4°.

With the LDG in the DOWN position, the status of automatic NWS & L/D availability upon landing is indicated as follows:

NWS lit and “NWS” legend not illuminated nor flashing on FCS RSET button:

- No automatic engagement of the NWS or L/D.

NWS lit but “NWS” legend flashing on FCS RSET button:

- No automatic engagement, but pressing the FCS RSET push button makes automatic engagement available on landing.

NWS caption not lit but “NWS” legend flashing on FCS RSET button:

- Automatic engagement on landing provided with a delay of 2 seconds, indicating reduced redundancy of WOWs.

NOTE

- IF NW IS BEING JAMMED ON THE GROUND THEN THE RED <NWS> WARNING CAPTION IS ALREADY DISPLAYED ON T/O.
- IF THE NWS WARNING CAPTION IS DISPLAYED IN FLIGHT WITH THE LDG IN THE UP POSITION, THE ONLY REASON FOR THIS WOULD BE A L UTIL P FAILURE CONDITION.

AER(EP).1F-EF2000(T)-1

If NWS is accompanied by a FCS 1 and/or FCS 2 warning, this has the following meaning:

– FCS 1 may indicate an FCC failure; in this case the NWS is lost.

– FCS 1 and/or FCS 2 due to a 2 vs 2 failure (WoNW), i.e. NW weight is unknown; NWS is lost.

NWS Failure - Approach / Landing

CAUTION

IF LATERAL DIRECTIONAL PROBLEMS OCCUR DURING X-WIND LANDING, JETTISON BRAKE CHUTE.

NOTE

Consider approach-end-cable engagement (refer to Cable Engagement - Approach End pag. 3-59) or aerodynamic braking.

NWS With Additional FCS Failures

NWS

FCS 1

and/or FCS 2

After main wheel touchdown:

1. Brake chute ..... Deploy
2. De-rotate ..... Immediately
3. Stick ..... Full forward until brakes applied
4. Directional control ..... Use rudder and differential braking below 90 KDAS

For landings in x-wind greater than 20 kt, or if x-wind greater or equal to 10 kt and lateral CG imbalance > 175 kg present:

After mainwheel touchdown:

1. De-rotate ..... Immediately
2. Stick ..... Full forward and roll into wind until brakes applied
3. Brake chute ..... Deploy
4. Directional control ..... Use rudder and differential braking below 90 KDAS

NWS Without Additional FCS Failures

NWS

After main wheel touchdown:

1. Brake chute ..... Deploy
2. Stick ..... Full forward until brakes applied
3. Directional control ..... Use rudder and differential braking below 90 KDAS

For landings in x-wind greater than 20 kt, or if x-wind greater or equal to 10 kt and lateral CG imbalance > 175 kg present:

After mainwheel touchdown:

1. De-rotate ..... As soon as practicable
2. Stick ..... Full forward and roll into wind until brakes applied
3. Brake chute ..... Deploy
4. Directional control ..... Use rudder and differential braking below 90 KDAS

NWS Failure-Pre Take-off/Landing

(1B-B-15-46-04-01A-141A-A Issue 004)

NWS

FCS 1

and/or FCS 2

Disengagement of the NWS is indicated by:

If NWS is displayed:

– NWS is disengaged by ICO, or a NW jammed on ground (flight latched) condition is present.

Flashing the “NWS” legend on the FCS RSET push button at 1.25 Hz:

AER(EP).1F-EF2000(T)-1

– NWS can be engaged via the FCS RSET push button.

"NWS" legend on FCS RSET button not lit:

– NWS cannot be engaged due to NWS position range out of limits or ADS failure in flight latched condition.

If NWS is displayed on landing (WONW) the nose wheel is in free castor mode. The aircraft can be steered by differential braking and/or rudder effectiveness.

NOTE

– IF DURING CROSSWIND LANDINGS THE BRAKE CHUTE IS SELECTED ON MW TOUCHDOWN AND A NOSE WHEEL FAILURE IS ENCOUNTERED ON NOSE WHEEL TOUCHDOWN, LEADING TO LATERAL/DIRECTIONAL CONTROL PROBLEMS, THEN THE BRAKE CHUTE SHALL BE JETTISONED.

– STEERING AT LOW SPEEDS MAY BE DIFFICULT. STOP, SHUT DOWN AND TOW-IN MAY BE NECESSARY.

Brakes Failure

(1B-B-15-46-05-00A-141A-A Issue 007)

BRK FAIL *

* CAT 3 T/O POF.

The warning caption is displayed following double brake system failure (system 1 and system 2) in all POF. The ACUE format will display a BRAKE NOGO (GND POF). There is a possibility that the A/SKID warning is triggered as well.

On the ground, if a single brake failure is detected, the ACUE format will display BRAKE NOGO BRAKE SYSTEM 1 FAIL (or BRAKE SYSTEM 2 FAIL).

In flight, if a single brake failure is detected in brake system 1 (left), the LGC will automatically switch to brake system 2 without displaying a cockpit warning.

In case of a LGC failure and a pilot detected brake failure, manual changeover from one brake system to the other by the cockpit selectable BRK NORM-REV switch is possible.

1. Land ..... Refer to Cable Engagement - Approach End pag. 3-59 or Cable Engagement - Departure End pag. 3-59.

Anti-Skid Failure

(1B-B-15-46-06-00A-141A-A Issue 007)

A/SKID *

* CAT 3 in GND & T/O POF.

The warning is displayed in case of a total anti-skid system failure (both systems).

At unfavourable conditions, an approach or departure-end cable engagement should be considered.

1. Land ..... Refer to Cable Engagement - Approach End pag. 3-59 or Cable Engagement - Departure End pag. 3-59.
2. Brakes ..... Use with caution

Hook Down

(1B-B-15-46-07-00A-141A-A Issue 003)

Description

HOOK	GND, T/O, APP and LDG
HOOK	NAV and COMB

Illumination of the HOOK DWN caption on the DWP indicates that the arrester hook is not stowed and locked, without having pressed the arrester hook release pushbutton. Additionally, the arrester hook release pushbutton light is on. n flight, if the HOOK DWN caption comes on consider cable engagement or remove cable.

Procedure

1. Land ..... Consider removing approach-end-cable or refer to Approach-End-Cable

AER(EP).1F-EF2000(T)-1

Cable Engagement - Departure End

(1B-B-15-46-14-00A-141A-A Issue 002)

Description

Make a departure-end-cable engagement when there is a stopping problem (that is, aborted takeoff, wet or icy runway, loss of brakes, etc.) and it is not possible to make an approach-end-cable engagement.
Engage as close to center as possible, in a three-point attitude, with feet off brakes and aligned with the runway. Place the hook down at least 1000 feet before cable, and reduce speed as much as possible. If there is a directional control problem, use differential brake and/or power.

CAUTION

CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY RESULT IN NOSE GEAR AND/OR EXTENSIVE AIRCRAFT DAMAGE.

NOTE

If there are lamps in the runway centerline, an off-center distance of 3 feet is considered the best condition for rolling with the hook down.

After engagement, maintain throttles at idle and await groundcrew instructions.

Procedure

CAUTION

- CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY RESULT IN AIRCRAFT DAMAGE.

- DO NOT USE BRAKES TO ARREST ROLL BACK.

1. Throttles..... IDLE
2. Brake chute ..... Deploy
3. Hook ..... Down (1000 ft before cable), light on
4. Brakes ..... Release 2-3 seconds prior cable

Cable Engagement - Approach End

(1B-B-15-46-15-00A-141A-A Issue 003)

Description

Make an approach-end-cable engagement when there is a directional control problem, or an anticipated stopping problem.
Consider the type of emergency, availability of backup cable, runway condition and length, weather, fuel state and any other pertinent factors in determining the proper action in event of a missed engagement.
Determine maximum engagement groundspeed at landing gross mass (see Table , “Maximum Engagement Groundspeeds,” on page 3-60) and the touchdown speed. If it is required, reduce aircraft gross mass to minimum possible.
If committed to an approach-end-cable engagement, lock shoulder harness and lower the hook after starting approach.
Touchdown at least 500 ft from the cable to allow enough time to lower the nosewheel to the runway before engagement. Touchdown as close to centerline as possible. Engage the cable in a three-point attitude and with feet off brakes. Throttles must be at idle before engagement.

CAUTION

CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY RESULT IN NOSE GEAR AND/OR EXTENSIVE AIRCRAFT DAMAGE.

NOTE

If there are lamps in the runway centerline, an off-center distance of 3 feet is considered the best condition for rolling with the hook down.

Be prepared for departure-end-cable engagement if cable is missed.
After engagement, maintain throttles at idle.

AER(EP).1F-EF2000(T)-1
After rolling backwards, keep engine running and await groundcrew instructions.

WARNING

THE TABLE BELOW REPRESENTS A COMBINATION OF ARRESTER GEAR AND AIRCRAFT/HOOK STRUCTURE LIMITATIONS. EXCEEDING THESE LIMITATIONS WILL CAUSE ARRESTING SYSTEM FAILURE AND/OR STRUCTURAL AIRCRAFT/HOOK DAMAGE.

NOTE

Maximum engagement groundspeeds are valid only with idle thrust.

Maximum Engagement Groundspeeds

AIRCRAFT MASS (KG)	MAXIMUM CABLE ENTRY GROUNDSPEEDS - KT									
	AAE 44B-2C	AAE 44B-2D (NATO)	AAE 44B-2D (GAF)	AAE 44B-2E	AAE 44B-2L	SUPER BAK9	BAK12 E32A	BAK13 AM.1	RHAG MK-1	ADEC 500 S-8
12 000	178	172	164	190	175	190	185	152	160	177
14 000	178	168	164	186	175	190	180	148	160	170
16 000	178	163	164	181	175	190	175	145	160	164
17 000	178	160	162	179	175	190	171	143	160	161
18 000	175	159	160	177	175	190	169	142	160	159
19 000	170	157	158	175	175	185	165	141	158	157
20 000	165	154	155	173	175	182	160	140	156	155
21 000	160	151	153	171	175	177	155	139	154	153

Procedure

CAUTION

- CABLE ENGAGEMENT WITH NOSEWHEEL OFF GROUND MAY RESULT IN AIRCRAFT DAMAGE.

- DO NOT USE BRAKES TO ARREST ROLL BACK.

1. Aircraft mass .....Reduce to minimum practicable
2. Hook.....Down, light on
3. Touchdown.....Minimum 500 ft before cable
4. Throttles .....IDLE
5. Brake chute .....Deploy
6. Nosewheel..... Lower in front of cable
7. Brakes ..... Do not apply

LANDING GEAR FAILURES

Landing Gear Retraction Failure

(1B-B-15-46-08-00A-141A-A Issue 006)

Illumination of the two red displays in the landing gear handle indicate that the landing gear doors or legs are not fully locked into the position selected with the landing gear handle.
LDG voice warnings are triggered in all POF except GND as follows:

– GEAR TRAVEL - CAT4, if LDG DOWN or is not UP and speed exceeding 290 KDAS, but less than 320 KDAS.
– GEAR LIMIT - CAT 1, if 320 KDAS are exceeded.
– In both cases, the “GEAR” symbol flashes on HUD.

AER(EP).1F-EF2000(T)-1

NOTE

If the landing gear handle is stuck in the UP position, the FCS control laws do not switch to the landing gear down control laws, i.e. the roll rate does not decrease and is very sensitive.

If the gear handle is stuck down:

1. Gear handle ..... Leave down
2. Speed ..... Below 290 KDAS

If the gear handle is UP and one or more lights illuminated:

1. Landing gear handle .. DOWN, below 290 KDAS, 3 green / 3 D

If gear not fully locked down (green missing, red displayed), refer to Landing Gear Fails to Lower pag. 3-61.

Landing Gear Fails to Lower

(1B-B-15-46-09-00A-141A-A Issue 006)

The CAT 1 warning “LANDING GEAR” is triggered if the LDG is UP and airspeed is below 180 KDAS, RAD ALT below 500 ft and both throttles below 89% NH.

If the landing gear is not following the DOWN command of the landing gear handle, the gear can be lowered by means of the emergency gear switch (EMGY GEAR) which is hardwired to a combined gear and door selector valve, thus by-passing the landing gear computer (LGC). The landing gear can be lowered even if the normal landing gear selector handle is stuck in the UP position. The landing/taxi lights are not available since those are triggered only with the landing gear handle in the DOWN position.

In general the NWS is operative when the EMGY GEAR is selected to DOWN, provided the changeover to the right utilities system is not dictated by loss of the left utilities system.

If the landing gear handle is stuck in the UP position, the FCS control laws do not switch to the landing gear down control laws. Hence, roll rate does not decrease and is very sensitive.

1. Landing Gear handle ..... Confirm DOWN

WARNING

FOLLOWING SELECTION OF EMGY GEAR TO DOWN, SELECTION OF RESET WILL RETRACT THE LANDING GEAR, IRRESPECTIVE OF AIRCRAFT WEIGHT-ON-WHEEL SWITCHES, IF THE LANDING GEAR HANDLE IS IN THE UP POSITION.

2. EMGY GEAR switch .. DOWN

If either HUD or HD indicates 3 D or 3 green:

3. Land

If landing gear position on both displays still unsafe:

4. Land ..... Refer to Landing with Gear Unsafe pag. 3-61.

Landing with Gear Unsafe

(1B-B-15-46-10-00A-141A-A Issue 006)

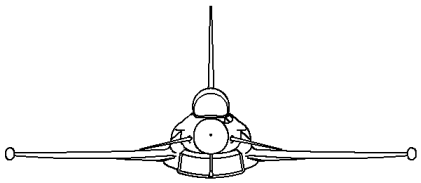
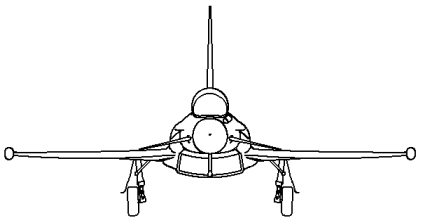
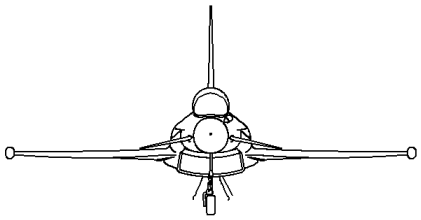
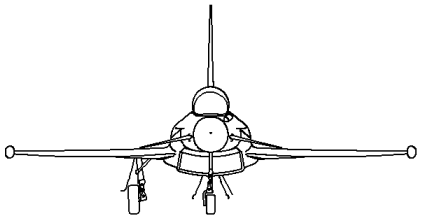
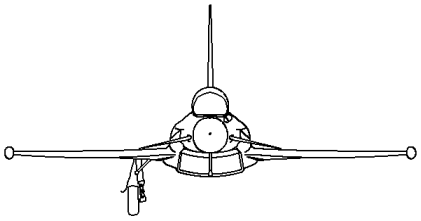
Before landing consider:

- Condition of runway, overrun, side areas
- Crosswind
- Arrester gear limitations
- Availability of foam

NOTE

- NORMAL CANOPY OPENING IS NOT AVAILABLE WITHOUT WEIGHT ON ALL WHEELS.
- IF EITHER HUD OR HD INDICATES 3D OR 3 GREEN, THE DOWN INDICATION CAN BE RELIED UPON.

1. Aircraft mass ..... Reduce to min. practicable refer to Recommended Actions Table , “,” on page 3-62

GEAR POSITION	RECOMMENDED ACTIONS
All gear up 	Jettison all live ordnance Jettison asymmetric stores Retain empty fuel tanks Low angle approach Have cable removed, do not touchdown before cable After touchdown: HP SHUT, LP COCKS SHUT, BATT-OFF
Both main gear down - Nose gear unsafe 	Retain empty fuel tanks Low angle approach Perform aerodynamic braking Brake chute-Deploy Do not use wheel brakes until the nose is on the ground Have cable removed, do not cross cable with nose lowered De-rotate gently by 100 KDAS before running out of pitch control When stopped: HP SHUT, LP COCKS SHUT, BATT-OFF
Both main gear up - Nose gear down 	NOTE: Expect touchdown on the nose gear first. Jettison all live ordnance Jettison asymmetric stores Retain empty fuel tanks Low angle approach Have cable removed, do not touchdown before cable Brake chute-Deploy After touchdown: HP SHUT, LP COCKS SHUT, BATT-OFF
One main gear unsafe-Nose gear down 	EMGY GEAR switch to RSET LDG lever UP If unable to obtain other configurations: EJECT
One main gear unsafe-Nose gear up 	EMGY GEAR switch to RSET LDG lever UP If unable to obtain other configurations: EJECT

Landing Gear Collapsing

(1B-B-15-46-11-00A-141A-A Issue 006)

Should the main landing gear collapse, the nosewheel will most probably collapse as well or break.

For emergency engine shut-down, the battery can be set to OFF before the engines stop. HP COCK and LP COCK should always be shut (fire protection).

Although the canopy is directly wired to PP6 and normal canopy opening would be possible after battery switch off, weight on all wheels is required to open the canopy with the cockpit internal switch.

Landing with a Known Blown Tire

(1B-B-15-46-12-00A-141A-A Issue 007)

If a main tire is blown directional oscillations and/or control problems may occur and an approach-end-cable engagement is recommended. If an approach-end-cable engagement is not practicable, lower the nose as soon as practicable. Nosewheel steering will assist directional control.

Before landing consider:

– Condition of runway, overrun, side areas
– Crosswind
– Arrestor gear limitations

1. Aircraft mass..... Reduce to min practicable

Fly a shallow approach.

If nose tire blown:

2. Brake chute ..... Deploy at mainwheel touchdown
3. De-rotate..... As late as practicable

If main tire blown:

2. Land ..... Approach-end-cable engagement recommended, refer to Cable Engagement - Approach End pag. 3-59

If approach-end-cable engagement not practicable:

3. Land..... On side of runway towards good tire
4. Wings..... Maintain level
5. Nosewheel..... Lower ASAP
6. Brake chute ..... Deploy

Brake Chute Loss of Function

(1B-B-15-46-13-00A-141A-A Issue 004)

CHUTE

The warning is displayed in GND, T/O and APPR POFs.

In general there is no problem to stop the aircraft within the standard NATO runway length following the loss of brake chute function indication on approach. Consider aerodynamic braking. If crosswind dictate to perform a normal landing, use full forward and roll into wind stick until brakes are applied. At unfavorable condition, such as wet or poor runway, consider the use of the departure end cable and lower the hook.

ARMAMENT SYSTEM FAILURES

ACS Failure

(1B-B-15-70-00-00A-141A-A Issue 005)

ACS FAIL

FCS MASS

SCAC

REV ENV

In the event of ACS failure the weapons/stores control function is lost with the exception of the emergency jettison. The stores configuration data supplied to the flight control system are lost. If the failure cannot be reset the mission should be aborted.

All ACS functionality lost except for Emergency Jettison

SCAC Failure

(1B-B-15-70-20-00A-141A-A Issue 004)

SCAC

FCS MASS

REV ENV

In the event of SCAC failure the weapons/stores control function can be lost with the exception of the emergency jettison.

NOTE

Use of the NORM/REV switch in REV position authorizes ACS to operate in single channel mode.

No stores displayed on STOR format

1. SCAC NORM/REV switch..... REV

AER(EP).1F-EF2000(T)-1

If STOR format resumed:

2. Continue mission with SCAC in reversionary mode (re-enter SJ package)

If STOR format still empty:

2. SCAC NORM/REV switch .....NORM then REV within 3 seconds

If STOR format resumed:

3. Continue mission with SCAC in reversionary mode (re-enter SJ package)

If STOR format still empty:

3. All ACS functions are lost except for Emergency Jettison

NSCAC Failure

(1B-B-15-70-30-00A-141A-A Issue 005)

NSCAC

ACS FAIL

with or without **FCS MASS**

with or without **SJ FAIL** if jettisonable stores

REV ENV

In the event of NSCAC double channel failure the weapons/stores control function is lost with the exception of gun and emergency jettison. The stores configuration data supplied to the flight control system are lost.
NSCAC double channel failure resulting in:

– Loss of missile firing
– Loss of SJ functionality
– Loss of stores data to FCS.
– STOR format:
  - tanks displayed if fitted
  - stores with red rectangle

DU Failure

(1B-B-15-70-40-00A-141A-A Issue 003)

DU FAIL

ACS FAIL

Both DU channels fail, leading to the complete loss of missiles availability for firing. Gun operations, EJ/SJ and interface with FCS are still available.

DU double channel failure resulting in:

– Loss of missile firing
– HUD shows zero AMRAAM and zero SRAAM

EJ Failure

(1B-B-15-70-50-00A-141A-A Issue 003)

EJ FAIL with or without

SJ FAIL

Loss of Emergency Jettison function.

1. MASS ..... Maintain LIVE for the remainder of the sortie

SJ Failure

(1B-B-15-70-60-00A-141A-A Issue 003)

SJ FAIL

Loss of Selective Jettison function.

1. MASS ..... Maintain LIVE for the remainder of the sortie

Gun Failure

(1B-B-15-74-00-00A-141A-A Issue 003)

GUN FAIL

A gun failure will be indicated by a category 3 warning on the DWP and the MHDD Stores format when a failure is detected within the gun system. The SCAC will stop gun firing immediately and further gun firing will be inhibited.

Gun Scoop Failure

(1B-B-15-74-01-00A-141A-A Issue 003)

GN SCOOP

with **GUN FAIL**

A gun scoop failure will be indicated by a category 3 warning on the DWP and the MHDD Stores format when a failure is detected within the simulated gun scoop system. The SCAC will stop gun firing immediately and further gun firing will be inhibited. GUN FAIL will be displayed as a secondary warning also.

SECTION 4 - ADVERSE WEATHER

TABLE OF CONTENTS

Title	Page
Turbulence and Thunderstorms	4-1
Snow, Ice, Rain and Slush	4-1
Effects of Ice and Snow during Takeoff	4-2
Operation in Extreme Conditions	4-2

Turbulence and Thunderstorms

(1B-B-15-50-05-00A-043A-A Issue 002)

Introduction

NOTE

Currently, there is no flight experience in turbulent conditions and thunderstorms.

The advice offered in this Section is general in its scope, and will be up-issued when more experience is gained using the aircraft under these adverse weather conditions.

Limitations

The limitations for aircraft operation in turbulence and thunderstorms can be found in Section 5.

Procedure

During flight the pilot shall use his experience and any additional information to avoid and fly around turbulence and thunderstorms. If turbulence or thunderstorm activity is encountered whilst flying the aircraft at high speed, the aircraft should be decelerated towards 250-300 KDAS and the most expeditious route to clear the adverse weather should be attempted.

Snow, Ice, Rain and Slush

(1B-B-15-50-10-00A-043A-A Issue 002)

Introduction

NOTE

Currently, experience of operating the aircraft in snow, ice, rain and slush is minimal.

The advice offered in this Section is general in its scope. The Section will be updated when more experience is gained using the aircraft under these adverse weather conditions.

Limitations

The limitations for aircraft operation in snow, ice, rain and slush can be found in Section 5.

Protection on the Ground

Whilst design measures have attempted to prevent the undesirable ingress of precipitation to the panels and bays of the airframe, every effort should be made to avoid unnecessary exposure to precipitation during ingress and egress. Access to the cockpit and avionic compartments should be kept to the minimum essential for aircraft safety and crewing. If the aircraft is to be left for an extended period in heavy rain, blanks and covers should be fitted.

Minimize the time the canopy is open to reduce the amount of precipitation falling into the cockpit and onto the consoles. As soon as practicable, close the canopy. Strapping-in without groundcrew assistance is easily achievable. Starting the APU at an early stage will minimize any potential for misting.

Wherever possible use de-icing fluid to clear the airframe of accumulated snow and ice; to prevent damage, do not chip ice off the airframe or canopy.

Taxiing

Extra care should be taken when taxiing on partially cleared dispersals and taxiways. Taxi slowly across snow or ice ridges to reduce landing gear loads. Taxi slowly across any area of standing slush to reduce the amount of slush blown onto the landing gear and landing gear microswitches.

Takeoff

WARNING

UNDER NO CIRCUMSTANCES SHOULD TAKEOFF BE ATTEMPTED WITH SIGNIFICANT VISIBLE BUILD UP OF SNOW, ICE OR SLUSH ON THE FOREPLANES OR WINGS.

Significant in this context is defined as greater than 10 mm of ice or 20 mm of snow or slush.

A maximum reheat takeoff should be undertaken to minimize the potential for directional control difficulties prior to the flight control surfaces becoming fully effective and to minimize the time on the ground. After lift off leave the landing gear down

for a short period of time to allow any accumulated snow or slush to be blown away from the landing gear and landing gear bays.

Landing

If the runway surface conditions are particularly poor, consideration should be given to an approach end cable engagement. Alternatively, if practical, divert to an airfield with a clearer runway surface.

If the decision is made to land where poor surface conditions exist, a normal approach and touchdown should be flown. Upon mainwheel touchdown, stream the brake parachute to decelerate the aircraft as much as possible and only apply gentle/ cautious braking if essential to bring the speed down to taxi clear of the runway.

If directional control problems are encountered prior to applying wheel brakes consideration should be given to jettisoning the brake parachute. If directional control problems are encountered as a result of braking, reduce the severity of the inputs as much as possible and consider a departure end cable engagement.

Effects of Ice and Snow during Takeoff

(1B-B-15-50-15-00A-043A-A Issue 002)

Introduction

NOTE

Currently, takeoff experience in the presence of ice and snow does not exist.

The advice offered in this Section is general in its scope. The Section will be updated when more experience is gained using the aircraft under these adverse weather conditions.

Limitations

The limitations for aircraft operation in ice and snow, during takeoff conditions can be found in Section 5.

Procedure

WARNING

UNDER NO CIRCUMSTANCES SHOULD TAKEOFF BE ATTEMPTED WITH SIGNIFICANT VISIBLE BUILD UP OF SNOW, ICE OR SLUSH ON THE FOREPLANES OR WINGS.

Significant, in this context, is defined as greater than 10 mm of ice or 20 mm of snow or slush.

The presence of ice and/or snow during takeoff is thought to have no unique peculiarities in this aircraft when compared to other high performance aircraft. The presence of snow or ice will have a significant effect on the performance figures, particularly in the case of an aborted or rejected takeoff, where stopping distances will be significantly increased.

Accumulations of ice and snow on the lifting surfaces and the varicowl/intake sidewalls will adversely affect performance. Accretions of over 3 mm must therefore be de-iced prior to takeoff. Minimize the time spent on the ground at high engine power in order to reduce intake icing before takeoff.

A maximum reheat takeoff should be undertaken to minimize the potential for directional control difficulties prior to the flight control surfaces becoming fully effective and to minimize the time on the ground. After lift off leave the landing gear down for a short period of time to allow any accumulated snow or slush to be blown away from the landing gear and landing gear bays.

Operation in Extreme Conditions

(1B-B-15-50-20-00A-043A-A Issue 002)

Introduction

NOTE

Currently, operating experience in extreme conditions of heat and cold is minimal.

The advice offered in this Section is general in its scope. The Data Module will be updated when more experience is gained using the aircraft under these adverse weather conditions.

Limitations

The limitations for aircraft operation in extreme conditions can be found in Section 5.

Cold Weather Operations

The operation of this aircraft in conditions of extreme cold is considered to have no unique peculiarities when compared to other high performance aircraft.

Hot Weather Operations

The operation of this aircraft in conditions of extreme heat is considered to have no unique peculiarities when compared to other high performance aircraft.

SECTION 5 - OPERATING LIMITATIONS

Refer to applicable AIRWORTHINESS FLIGHT LIMITATION document

SECTION 6 - FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

Title	Page
Flight Characteristics	6-1
Flight with Asymmetrical Stores	6-1
Flights with Autopilot/Autothrottle	6-1
Flights under Subsonic Conditions	6-2
Flights Under Transonic and Supersonic Conditions	6-3
Single Engine	6-6

FLIGHT CHARACTERISTICS

Flight with Asymmetrical Stores

(1B-B-15-20-04-00A-043A-A Issue 002)

Asymmetric loading conditions are generally due to:

– asymmetric basic airframe,

– asymmetric store configuration due to deliberate release or hung-up,

– asymmetric fuel transfer and fuel sloshing which cause a lateral imbalance.

The CG caption on the DWP informs the pilot that estimated / calculated CG exceeds the cleared boundaries.

In case of no CG warning indication, the effects on handling characteristics due to a lateral CG offset in the baseline configuration are small and the relevant A/C behavior is easily counteracted by flight controls as long as the pilot flies within the allowed envelope.

In case of triggered lateral CG warning, instead, the effect on handling characteristics can be very pronounced and a recovery within the return to base envelope is required immediately following the defined procedures. Outside the allowed envelope application of roll or yaw inputs can lead to lateral departure.

In case of CG warning during approach and landing with strong crosswinds, to avoid risk of lateral control saturation, apply the dedicated procedure maintaining the angle of attack below the defined limitations.

Flights with Autopilot/Autothrottle

(1B-B-15-20-06-00A-043A-A Issue 002)

NOTE

At this software standard the Autopilot (AP) is omitted. The AP will be implemented in FPSP1b.

The AT is a very useful device for pilot workload reduction in all phases of flight. It must be noticed that the FPSP1a AT is an interim standard, and major improvements will be implemented in FPSP1b.

Takeoff and Climb

The use of the AT is recommended for normal IFR-type climb out. The speed datum can be set prior takeoff to 300-350 KDAS as required. Note that the aircraft in baseline configuration will climb at > 20° of pitch in max dry power initially, which can provoke vertigo in IMC and make intermediate altitude restrictions difficult to meet. Once airborne the AT can be engaged.

NOTE

When the AT is engaged far from the set speed datum, nuisance “SELECT REHEAT” CAT 4 voice warnings can be expected.

The AT will provide accurate speed control up to ~ FL 250 when using no more than 10° of climb attitude. For climb at higher levels it is recommended to disconnect the use of AT and use max dry power.

Cruise

For medium and low level cruise the AT will provide very accurate speed control throughout the subsonic envelope. At high level the AT and the engine controls are incompatible, which may lead to the AT being unable to keep the desired speed (the minimum controllable speed above ~ FL 350 is ~ 0.96 Mach). This problem is solved with the introduction of FPSP1b.

Combat

In addition to the above mentioned features aircrew may find the AT a workload reduction during intercepts, and the AT has been found very helpful in

attaining and maintaining mid-supersonic speeds. If a higher speed is desired, the new datum can be set with the AT engaged or not. Once the AT is engaged with a higher speed datum set, the pilot should wait for the voice prompt “SELECT REHEAT”. This removes the force from the AT servos, and the pilot can easily push the throttles through the reheat detent. Once both throttles are in reheat, the AT will continue to operate. The AT will automatically cancel reheat when no longer required (for instance when a low speed datum is selected with AT engaged at high supersonic speed). Operation with AT on the reheat border (for instance Mach 1.1-1.2 at high altitudes) will cause frequent reheat demands and automatic reheat cancellations as the AT attempts to modulate in and out of reheat.

Descent

The AT in its present configuration has been found to be of little operational value during descent. The problem is that the minimum governing power setting of the AT is too high to be compatible with the “slippery” Eurofighter. At FPSP1b, the AT will be able to utilise the full power range down to idle with the nozzles full open. This should make the AT a useful tool at least during normal IFR recoveries.

Approach and Landing

The AT has been found very helpful for speed control both during visual and IFR traffic patterns. During IFR recoveries it is furthermore highly recommended to use the AT on approach. As a technique, setting a speed datum of initially 150 KDAS, is adequate for initial descent in baseline configuration. The speed datum can be “inched” back to achieve the desirable final AOA of ~ 14°. With the present software configuration care should be taken not to disconnect the AT via ICO on short final as this will also disconnect the NWS. The AT should in any case be disconnected via AT button to initiating the flare.

Flights under Subsonic Conditions

(1B-B-15-20-08-00A-043A-A Issue 003)

General Handling and Maneuverability

The aircraft is generally extremely responsive and manoeuvrable. During transit flying and non-aggressive maneuvering the pitch rate demand is the predominant feature. Center stick produces a zero pitch and roll rate demand, hence, effectively providing a flight path hold response. Small stick deflections result in pitch and roll rate responses. Fixed stick inputs result in constant pitch and roll rate response, until transition into alpha demand is required. Response to larger stick deflections can be either an Nz demand, at higher speeds, or an alpha demand at lower speeds; appropriate limiting is ensured in either case.

The transition between each region is a transparent blend of control laws and anomalies or transients will not be experienced. The predominant characteristics to be noted when aggressively maneuvering the aircraft are as a result of the delta wing configuration and the high power to weight ratio. Hard maneuvering below approximately 300KDAS results in a high deceleration rate and associated transition from Nz limiting to alpha limiting. Unloaded accelerations at maximum reheat can result in speed gains in the region of 25-30KDAS/second.

The high power to weight ratio may result in unintentional accelerations to the high subsonic or transonic region, where generation of sonic booms may cause an unnecessary disturbance to the public. As a result a Cat 4 voice warning "Transonic" is provided when the aircraft is predicted to be 3 seconds from exceeding M0.98.

Physical feedback of aircraft maneuvering comes in two distinct regions. At 1g the majority of the flight envelope is ‘buffet free’ up to M0.95, where moderate buffeting commences and some slight wing drop/rock becomes apparent. During maneuvering flight or as speed reduces, an alpha related light buffeting becomes noticeable at 8 alpha.

Aerobatics and Combat Maneuvering

Maneuver Definitions

NOTE

Definitions are:

– CFH
– GML1(TBD) ETC.

At this standard Automatic Low Speed Recovery (ALSR) is not functional, therefore a pilot observed minimum speed is to be honoured. Carefree pilot inputs are permitted down to TBD KDAS, and between this speed and the cleared minimum speed definition (GML1-TBD), maneuvers can be performed until the “Speed Low Recover” voice warning is triggered.

Looping Maneuvers

Looping or ‘over the top’ maneuvers can be flown from a wide range of entry conditions once experience has been gained; the only relevant limitation to be observed is the minimum speed, during the maneuver. The height for a loop varies depending upon the entry speed, the power setting

and the Nz and alpha pulled during the maneuver; 2500ft is an achievable gate height.

Rolling Maneuvers

The aircraft is capable of generating a very high roll rate. The pilot's head is some distance above the roll axis of the aircraft and as a result the lateral acceleration experienced in the cockpit can be significantly greater than expected.

Roll rate varies as a function of speed, alpha and Nz. A maximum roll rate of 250°/second can be generated through a broad range of entry conditions. However, roll rates may be reduced to as low as 60°/second at low speed/high alpha or at very high speeds. The transition between differing roll rates can become apparent as the aircraft changes speed during rolling maneuver.

An unconventional feature of 1g rolling maneuvers comes as a result of the pitch rate demand control laws. A roll input from neutral pitch stick (i.e.zero pitch rate demanded) will see the cockpit Nz cycle from +1g through –1g and back to +1g as a 360° roll is flown. This unconventional Nz transient is a feature of all unloaded rolling manoeuvres and initially may appear slightly disconcerting but, once experience has been gained, is soon accepted.

Slow Speed Flight

NOTE

ALSR is not functional at this standard of FCS software.

The aircraft remains agile and responsive down to the minimum cleared airspeeds. At the higher AOA the view over the nose, along the aircraft's flight path, is restricted.

Sustained Maximum Rate Turning

The aircraft performance is characterized by a relatively flat zero Specific Excess Power (SEP) curve over a wide band of the subsonic envelope (refer to the Combat Performance Data Manual). Consequently, if the tactical requirement is to fight a rate fight then the pilot can achieve the best sustained turn rate at a wide range of speeds. The technique for establishing and sustaining a maximum rate of turn is the same as that for other fast jet aircraft; pull and monitor the airspeed.

Minimum Radius Turning

The aircraft does not suffer from a ‘stall’ type of lift loss as speed reduces and alpha increases. Therefore, the minimum radius turn is achieved at maximum alpha (FBS) at the minimum speed.

Manual Low Speed Recovery

If during maneuvering the aircraft speed is judged to be reducing and thought likely to decrease below the minimum cleared speed, or the “Speed Low Recover” voice warning is triggered, a manual recovery should be flown. In most cases this will simply involve a reduction in the amount of aft stick input to reduce the alpha and the acceleration rate. However, if the current flight path is more dynamic and/or vertical and/or power has been reduced, then a more ‘pilot involved’ recovery will be required.

Automatic Low Speed Recovery

ALSR is not functional at this standard of FCS software.

Flight with Airbrake Extended

Airbrake extension is scheduled as a function of both speed and AOA to ensure that the directional control is not adversely affected by the airbrake blanking the fin. The airbrake does not produce a significant increase in drag and consequently it is not particularly effective in decelerating the aircraft. A significant deceleration can be achieved by increasing the AOA by maneuvering the aircraft. Airbrake extension is characterized by a noticeable level of actuator noise as the airbrake is deployed. Once deployed a high frequency, low intensity vibration is apparent. There are no effects on the handling characteristics as a result of deploying the airbrake.

Night Flying

The operation of this aircraft in conditions of darkness is thought to have no unique peculiarities when compared to other high performance aircraft. Cockpit lighting and display brightness should be set as low as possible to minimize the potential distractions caused by minor internal canopy reflections. External lighting should be managed to minimize potential disorientation or dazzling effects to the pilots of other aircraft.

Flights Under Transonic and Supersonic Conditions

(1B-B-15-20-10-00A-043A-A Issue 002)

Handling Qualities

General

The level of manoeuvrability allowed in supersonic flights is full, use of controls in both pitch and roll is unrestricted. Use of pedals is allowed only in the proper sense.

In transonic there are no observed pitch limits and the use of control is unrestricted in pitch from full forward stick to full back stick, and up to full roll at all pitch sticks positions.
In general, no marked differences are noticed between S/S and T/S. The main differences stem from the more forward T/S cg, which tend to saturate controls surfaces (Flaps) at lower AOA than in S/S variant. This phenomenon affects the static stick forces vs gz characteristics as well as the trim capability in both symmetric and asymmetric configuration.
The airbrake out configurations exhibit a reduced directional stiffness, thus leading to a higher sideslip generation during lateral directional manoeuvering. Extension and retraction show no special behavior, but a small pitch down (less than 0.2 g) is noticeable around 1.2 M.
Asymmetric configurations has effect on the roll and yaw moment induced by the heavy wing. The effect is mainly counteracted by the wing leveller functions, improving the handling of aircraft under high lateral asymmetry. The most appreciable behavior is the reduction of the trim capability due to the use of the flaperons to both pitch and roll controls.
The calculated dive angle must be adjusted to take into account the altitude above the ground. The dive angle (°) must not exceed 30% of the indicated flight level. For example: if flying at an altitude of 15000 ft (FL 150), the maximum dive angle is 0.3*150 = 45°.
To provide adequate ground avoidance capability the following should be used for dives at transonic/ supersonic speed:
1 Set the Throttles to IDLE
2 If the aircraft is in a banked attitude, immediately roll to erect wings level flight, maintaining centre pitch stick
3 With wings levelled, pull FBS until a safe pull out is achieved. The use of the g-override provides any additional g-capability
4 In the event of a single hydraulic failure, recovery should be initiated immediately after a hydraulic failure warning.

Transonic

The aircraft exhibits large pitch transient due to the presence of an aerodynamic pitch up. This phenomenon is located at the following conditions:

– 0.93 M to 0.95 M between 6º - 8º AOA
– 0.97 M between 10º - 12º AOA

To overcome this problem a reduction of the load factor authority has been introduced (g-bucket) in the transonic region. The final transient is near 2g when performing deceleration through the transonic area. The reduction on load factor authority reduces the aircraft performances during dive pull outs affecting the recovery capability of the aircraft (see Figure 6.1). The g-bucket function is inhibited when pulling the stick to the g-override.
The existence of the pull up lead to a pitch handling characteristics being non linear and homogeneous.

Supersonic

The stick forces vs load factor/AOA, exhibit a dead zone characteristics at the full back position, when the maximum authority is reached. Pulling back from the maximum authority do not lead to an increase of pitch response, allowing the stick forces to increase proportionally to the deflection. This behavior does not affect the pitch control characteristics.
The maximum roll rate is reduced as speed approaches maximum speed (750 KEAS), but a minimum value of 40º/sec is ever provided under any circumstance.
The use of the same aerodynamic surfaces for pitch and roll control has influence on the manoeuvre to be performed for speed recovery. In order to avoid exceeding the maximum speed limit, use the following procedure to recover from dives at high supersonic speed:
1 If the aircraft is in a banked attitude, immediately roll to erect wings level flight, maintaining centre pitch stick.
2 With wings levelled, pull until reaching 600 KDAS and remain below 600 KDAS for the RTB. The use of the g-override provides an additional g-capability
3 Set the Throttles to Dry range
4 In the event of a single hydraulic failure, recovery should be initiated immediately after a hydraulic failure warning
5 The GAMMA-KDAS relationship defined in the Figure 6.1 must be respected (be aware that there are different values for symmetric and asymmetric configurations).

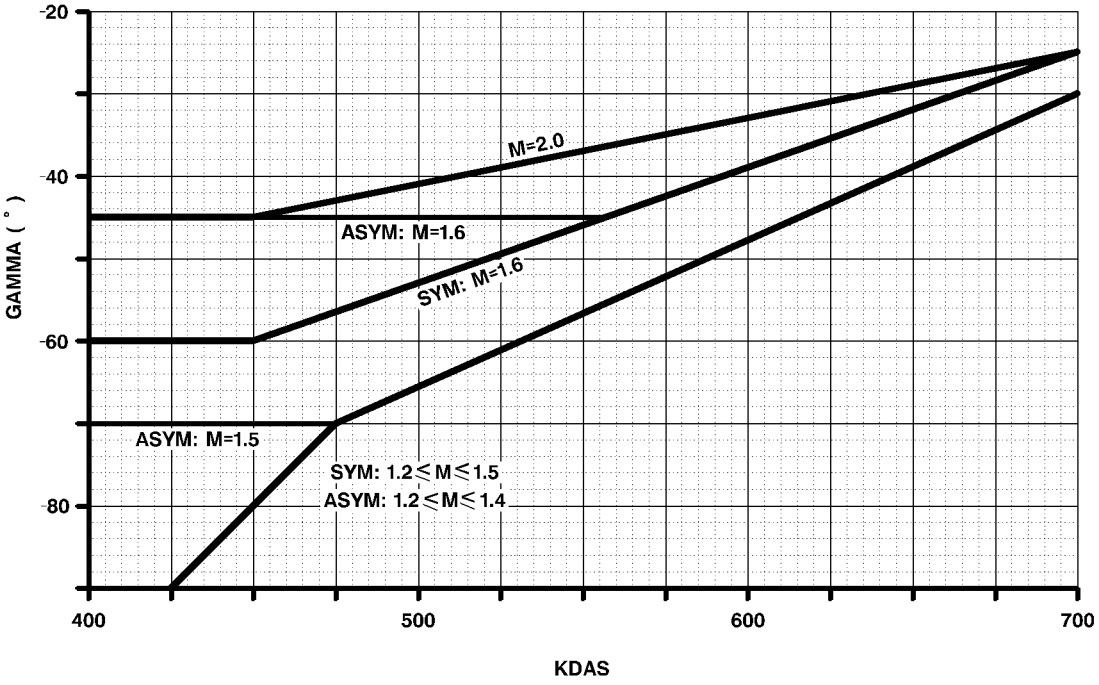


Figure 6.1 - GAMMA - KDAS Relationship

Single Engine

(1B-B-15-20-25-00A-043A-A Issue 002)

Asymmetric effects associated with single engine operation are slight and the relevant aircraft behavior is easily counteracted by flight controls.

Engine failure during take-off, beyond refusal speed, must be managed with smooth handling, maintaining the same rotation rate until lift-off occurs.

During approach and landing phases with one engine inoperative, slight rudder deflection is required to balance the asymmetric thrust.

An in-flight engine failure with both engines in maximum reheat causes an easily controlled minimal directional transient. Only at very low speeds, following an engine failure, a marked yaw transient can be noted. This can be successfully corrected by the application of a pedal input without the need to reduce thrust on the good engine.

Roll control power is always sufficient to maintain aircraft control.